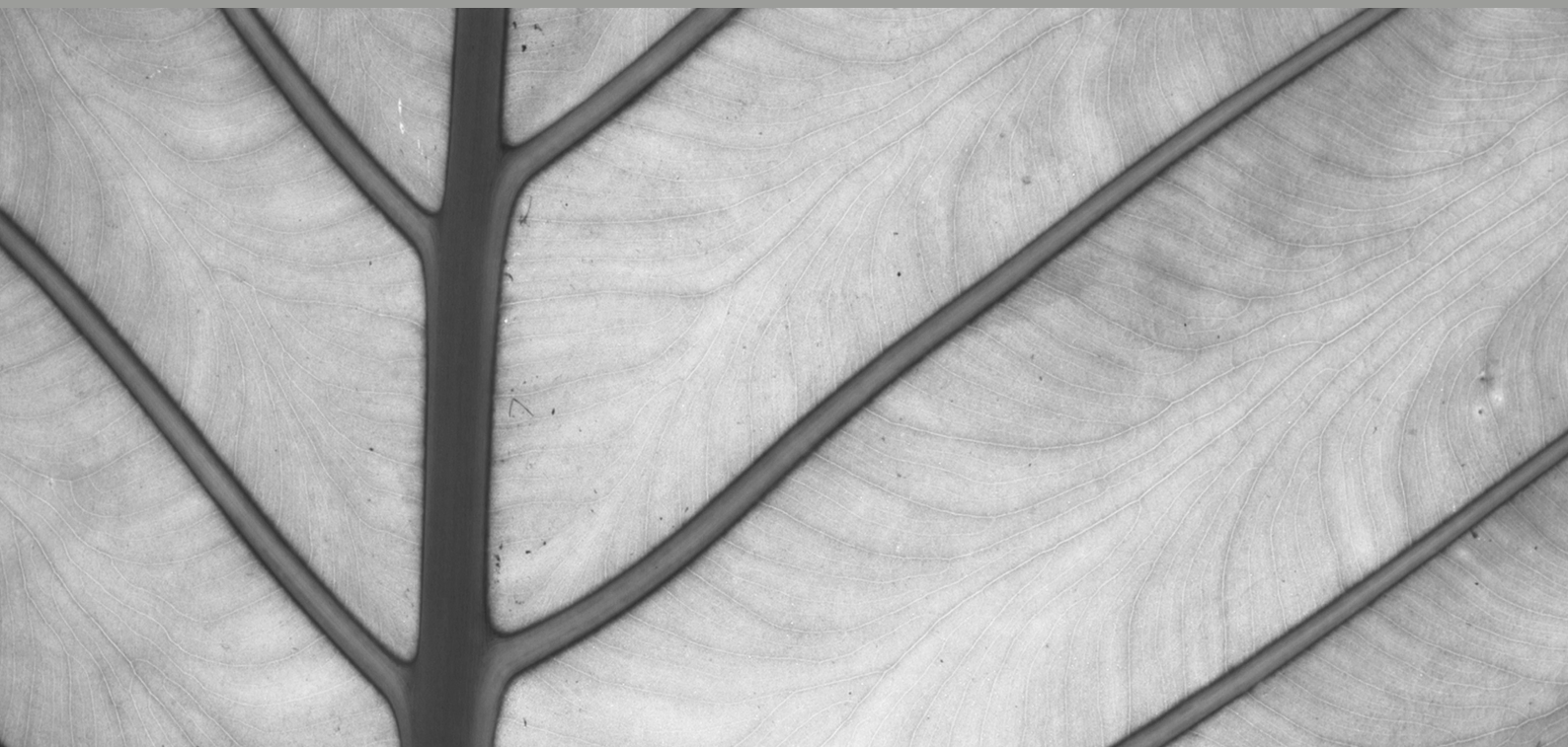
Research report 121

Accounting for Health



Accounting for Health

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Executive summary

This research developed out of ACCA ideas forums in Singapore, the UK and the US debating the link between health expenditure and outcomes, and the circumstances in which more expenditure delivers better outcomes. The forums brought forward a wide variety of viewpoints on these questions, which could, however, be grouped under three headings, those highlighting: the complexity of the research field; the impact of health demand- and supply-side factors on the relationship between expenditure and outcome; and the association between health financing systems and health outcomes.

The variety of topics discussed at the forums is mirrored in the literature on the subject. An extensive body of literature exists from which, as yet, no strong consensus emerges on the most important sources of good health or on the channels through which contributory sources operate. This work aims to reveal in more detail the relationship between health outcomes and expenditure on health. This relationship has attracted particular attention because in many countries expenditure on healthcare is rising faster than income and, within increasingly constrained economic and financial circumstances, the need to increase efficiency is ever more pressing. The approach proposed examines the causes of variations in health outcomes over countries with similar income levels. These variations may be explained, at least in part, by varying levels of expenditure on healthcare and its effectiveness.

Thus, an important unresolved question in discussions regarding the relationships between income, expenditure and health outcomes is the cause of the difference in health outcomes at given levels of income. Enhancing this understanding is the focus of this research.

AIMS OF THE RESEARCH

The research aimed to identify why some countries produce better health outcomes than others at the same level of income. The objectives of the research were:

- to assess the extent to which health expenditure and other factors modify the relationship between income and health outcomes
- to identify the common characteristics of well-performing countries in respect of health outcomes, at different levels of socio-economic development
- to explore the extent to which the characteristics of well-performing countries might be replicated.

METHODOLOGY

The methodology comprised a review of the literature followed by empirical statistical analysis. The literature review was prepared as a background for the empirical investigation and focused on factors that influence health outcomes across countries, once income is controlled for. Because of the vast scope of the research area, it is neither comprehensive nor systematic and is biased towards recent empirical, and quantitative, work. For the empirical analysis, we examined data from 173 countries on life expectancy, infant mortality and national income, along with a series of additional explanatory variables in line with the literature review and subject to data availability. The analysis was carried out for the years 1990, 2000 and 2006.

LITERATURE REVIEW

The sources of good health are multiple, complex and far from clear, and have attracted much attention in the quest to improve health outcomes. As a result, a large body of literature exists with, as yet, no strong consensus on the most important sources of good health. Nonetheless, the literature falls into four main themes: income and health outcomes; health expenditure and its effectiveness; health sector organisation and management; and the context of health outcomes. The most striking feature of the literature review is the lack of conclusive evidence, although some consensus emerges with regard to:

- the relationship of both personal and national income with health (but with a lack of insight into the causal pathways)
- the decreasing marginal returns of health outcomes to income
- the lack of a consistent positive correlation between health expenditure and health outcomes, because expenditure is mediated through complex systems of financing and delivery which in themselves affect health outcomes.

There is ample suggestive, but not conclusive, evidence that factors beyond expenditure affect levels of good health:

- relative income and income inequality
- institutions and incentives governing clinical behaviour
- political organisation
- social relationships
- health assets, such as health workforce and infrastructure but with significance levels often lower than anticipated
- environmental factors
- the demand for healthcare, but taking into account the lack of insights into incentives governing healthcare consumption.

Given the strong link between income and health, one of the most important outstanding questions concerns the differentials in health outcome at given levels of national income.

PRESTON CURVES FOR LIFE EXPECTANCY AND INFANT MORTALITY

In all three years examined in this study, the relationship between income and life expectancy or infant mortality rates flattens out.[1] This means that in countries with low levels of income per capita, increases in income result in large gains in life expectancy and equally large decreases of infant mortality rates. In countries with high levels of income per capita, however, additional income has little impact on these health outcomes. There is, therefore, a diminishing return in life expectancy with respect to additional income. The analysis also suggests that, at broadly similar levels of income, both life expectancy and infant mortality vary widely between countries, at least for low levels of income. This suggests that in low-income countries factors other than income are at play in determining health outcomes.

LIFE EXPECTANCY AND INFANT MORTALITY PERFORMANCE

A precise understanding of a country's health outcomes can be obtained by predicting the health outcome typically associated with its income level, and then comparing this with the country's actual performance. We applied this procedure for both life expectancy and infant mortality. The variation in performance is considerable for both measures of health outcome. Countries such as Equatorial Guinea and Swaziland have life expectancies that are more than 20 years less than what is predicted using their income level (by 29 and 24 years respectively). Life expectancy in Vietnam and Eritrea is about 10 years higher than expected on the basis of their income. And a similar variation is observed for infant mortality. The three countries in which the ACCA ideas forums took place, Singapore, the UK and the US, are bad performers for both outcome measures, although not dramatically so.

We can go a step further by combining the life expectancy and infant mortality rate performance with income per capita. This suggests that the high variation in health outcome performance is mainly concentrated in low-income countries, ie countries where income per capita is lower than USD 10,000 (in purchasing power parity terms[2]). When income per capita is higher than approximately USD 10,000, the values predicted (on the basis of income) for both life expectancy and infant mortality are much closer than for countries with lower income per capita. This then suggests that factors other than income drive health outcomes in low-income countries.

EXPLAINING HEALTH-OUTCOME PERFORMANCE

In the next step, the research sets out to explain health-outcome performance differentials. This is done by examining the effect of a number of independent variables on health-outcome performance. These variables are grouped under the following headings: organisation and management of the health sector; expenditure on healthcare; effectiveness of health expenditure; and contextual factors such as political stability or the quality of the regulatory environment.

Most of the independent variables contribute to explaining health-outcome performance, but not in a significant way. There is, furthermore, a degree of variation in the explanatory power of the same variable over years, which suggests either varying data quality or structural changes in how health outcomes are produced, or a combination of both, over time. The best predictors of health-outcome performance are the variables in management and organisation of the health sector, and numbers of hospital beds and physicians per 10,000 population, and this is true for both life expectancy and infant mortality rate. The number of hospital beds is especially relevant, as this explains 17% of the variation in infant mortality and 16% of variation in life expectancy in 2006, and so is a relatively strong single predictor. This then raises the question of what systemic aspects of the health system are embedded in a measure of hospital bed density.

THE POWER OF GEOGRAPHY AND TIME IN EXPLAINING HEALTH OUTCOME PERFORMANCE

The analysis so far does not conclusively identify the key variables that drive health outcomes, after controlling for income. The explanatory power of the variables also seems to change over time. One further step is then to disaggregate health outcome performance by region. This suggests the existence of regions with similar health outcome performance. Africa as a whole, for example, is clearly identified as an underperformer.

This insight led to a final element of analysis where we took into account time trends, regions and the effect of the independent variables identified in the previous section. First, we find that the explanatory power of the regional effects is very stark, and often explained up to an additional 50% of the variance in the performance on life expectancy and infant mortality. This suggests that between-region differences are sufficiently large to warrant carrying out the study of the drivers of good health at a regional level. This presents the challenge of determining what 'sufficiently homogeneous regions' are, and under

1. Preston was the first to describe the consistent pattern in the relationship between income and life expectancy or infant mortality. This relationship, which can be graphically represented in a curve, is referred to as 'Preston-curve'. We re-estimated Preston-curves in this study.

2. Purchasing power parity is a procedure that converts different currencies to one (in this case the dollar), correcting for the cost of living in each country.

what conditions insights from one region can be applied elsewhere. Second, the analysis shows that independent variables will have a different explanatory power with regard to health outcome performance by region. The contribution may not even be in the same direction: that is, sometimes the association will be positive, sometimes negative. This confirms that meaningful insights into what drives health outcomes, after controlling for income, is best done at the regional level.

DISCUSSION

The research question as to what drives health outcomes other than income levels is most starkly applicable to countries with income levels lower than USD 10,000 per capita. Interestingly, with regard to the initial research question, health expenditure (expressed in a variety of ways), does explain health outcomes but less so than the number of physicians and hospital bed density. But, overall, the analysis suggests that there are no clear and observable predictors of good or poor performance, other than geographical location. The unexplained differences between regions persist when the data are analysed across time, although actual outcomes converge on or diverge from expected outcomes at different rates with time.

The key question is then to identify factors represented by geographical location. These may include issues that are largely outside the remit of the health system, such as genetic endowment, and dietary and epidemiological realities unique to the regions in question. Moreover, it may be that the performance of the health system shows levels of similarity over geographic regions and, thus, explains the relative homogeneity in health outcome performance over regions. Moreover, health system performance is amenable to policy interventions, arguably more so than the factors outside the remit of the health system. Such evidence as exists suggests that variations may arise from differences in the institutions (rules) supporting the alignment and restraining the misalignment of service provider and citizens' interests. This suggests a need for further enquiry into the political economy of healthcare and a broader examination of the institutional arrangements governing political, social and economic transactions in different societies. This technically challenging research agenda remains to be tackled in a systematic, coherent way. It seems that a plausible way forward might be to undertake pilot studies of health performance based on enhanced methodologies incorporating differences in institutions and politician/manager/provider/consumer motivations in a few selected high- and low-performing countries in different regions.

1. Introduction

This research developed out of three ACCA ideas forums that debated the link between health expenditure and outcomes. We briefly summarise their proceedings before outlining the aim of this research and the methodology applied.

BACKGROUND

The ACCA ideas forum has been developed as a method of generating research output of relevance to a wide range of stakeholders. The format is a select, by-invitation-only forum which brings together small groups of academics and non-academics to debate key issues and develop ideas for future research. Three events were held around the world (UK, US and Singapore) in the first half of 2009, giving senior health professionals, policymakers and academics the opportunity to meet and debate some of the key issues surrounding the relationship between health outcomes and health expenditures. The excerpt from the introduction by the forum moderator, Dean Westcott, member of ACCA governing council and West Essex PCT finance director, below, sets out the objective of the discussions.

> *Healthcare systems globally are facing the same trends and tensions, namely aging populations, scientific and technological advances, rising wealth and increasing expectations. All of these factors are pushing up the demand for healthcare. But are these trends sustainable from an expenditure viewpoint, whether* [they] *be publicly or privately funded? Studies have estimated that by 2020, if nothing changes, healthcare expenditure could triple from current levels. This is against a background where healthcare spending has outstripped GDP by two percentage points each year for the past 50 years in OECD countries. The range, however, is significant with OECD countries spending between 6% and 15% of GPD on healthcare. But the question is does greater expenditure deliver better results in terms of healthcare outcomes?'*

In each forum, three speakers were asked to introduce the subject, followed by a discussion among approximately 15 participants. The discussions were invariably lively, with participants proposing various viewpoints rooted in their academic or practitioner backgrounds, which were then deliberated upon. Even if the country context did influence the debates, the arguments and opinions discussed across forums show a surprising level of similarity. The transcripts of the forum discussions are available from ACCA and must be read to appreciate the full breadth and depth of the discussions, but summaries of the main arguments could be clustered in four groups.

Complexity of the research question
Sound and credible studies may present seemingly contradictory findings when researching the link between health expenditure and health outcomes. One of the challenges is that the currently applied measures of health outcomes are not sufficiently precise to inform an accurate understanding of the link between spending and outcomes. On the one hand, it is recognised that highly aggregated measures of health outcomes and expenditure induces 'regression to the mean', where little meaningful detail about the relationship is revealed. At the other hand, the need to study the big picture is asserted.

Demand side
Characteristics of the healthcare demand side are often overlooked in comparing health outcomes for given levels of expenditure. In fact, social determinants, health inequalities, and social mobility not only drive health status indicators independently from access to healthcare, but also determine when and how individuals seek care. This is illustrated by the higher share of health expenditure accruing to both the poorer and richer segments in the US population, albeit for different reasons. In some states, poorer individuals incur high expenditure because of an above-average re-admittance for essentially preventable diseases, while richer populations tend to consume more expensive healthcare. Some patient populations may seek care only when their illness is advanced, leading to efficiency loss, while others may overuse, underuse or misuse care. Who seeks care and how they seek it therefore affect the efficiency of health expenditure in producing health outcomes.

Supply side
The impact of health expenditure on health outcomes is driven by the allocation of resources to the various types of care, on top of the much-debated efficiency in financing and service delivery systems. This is illustrated by the need for each health system to find the right balance between preventive and curative care, as well as inpatient and outpatient care, including day-centre care.

Health financing
The ways in which health services are financed involve different incentives, which affect the behaviour of the demand or supply side of care, or both. For example, increasing the co-payment for users provides a clear incentive for populations to limit ill health because of lifestyle. In this sense, alteration to co-payment levels may produce results similar to increased prevention efforts. Similarly, pay-for-performance financing systems are likely to elicit higher levels of efficiency in the provision of care. The extent to which populations are covered by health insurance will, all other factors being equal and at comparable levels of expenditure, determine access to healthcare and thus health outcomes. Health financing may also provide an answer to the central question 'how much is enough?' by focusing public efforts on the provision of a basic package of care but leaving the choice of paying for complementary care up to individuals (thus inevitably introducing inequity in financing of and demand for care).

The variety of topics put forward in the ideas forums is mirrored in the literature on the subject. To date, research has focused on a number of possible drivers of health outcomes:

- personal and income
- income inequality
- health expenditure
- efficiency and effectiveness of health expenditure
- health assets

- the demand for health services
- politics and institutions
- social determinants.

Opinions differ widely on the role of expenditure on healthcare in generating good health outcomes. Some believe it is of little significance, at least in low-income countries. Others are able to show improvements in mortality rates. There is considerable evidence that income is more important for good health than health expenditure and this is true across a wide range of national and personal incomes. This finding is particularly robust at national level for low- and middle-income levels. Nonetheless, the causal connection between economic growth and better health is contested. There are significant variations in health outcomes at the same level of national and personal income. There is substantial evidence for differences in health-sector performance and, although yet to be proven, these may help to explain differences in health outcomes at the same level of income.

A relatively new line of enquiry relates to the institutional policies and rules, incentives and organisational infrastructure that govern the behaviour of the key actors in planning and delivering health care. These include politicians, government bureaucrats, health services managers, clinicians, community organisations and health service users. While the evidence is rather fragmentary, it suggests that the behaviour of these agencies and actors is not always fully aligned for producing better health objectives and outcomes.

Other factors that have been demonstrated to influence health outcomes include education (particularly the education of the individual's mother), social organisation, environmental factors, political organisation, religion, and personal health and health-care-seeking beliefs and behaviours. Some, but not all of these, may be mediated by household economic status.

A huge body of literature exists but without, as yet, a strong consensus on the most important sources of good health or on the channels through which contributory sources operate. This research is intended to contribute to unpacking the complex relationship between health outcomes and expenditure on health. This relationship has attracted particular attention as expenditure on healthcare is rising faster than income and, within increasingly constrained economic and financial circumstances, the need to increase efficiency is ever more pressing. The approach proposed in this research examines the causes of these variations over different countries with similar income levels. These may be explained, at least in part, by expenditure on healthcare and its effectiveness.

Thus an important unresolved question in discussions regarding the relationships between income, expenditure and health outcomes is the cause of the difference in health outcomes at different levels of income. Enhancing this understanding is the focus of this research.

AIMS OF THE RESEARCH

The research aimed to identify why some countries produce better health outcomes than others at the same level of income. The objectives of the research were:

- to assess the extent to which health expenditure and other factors modify the relationship between income and health outcomes

- to identify the common characteristics of well-performing countries in respect of health outcomes, at different levels of socio-economic development.

METHODOLOGY

The methodology comprised a review of the literature followed by empirical statistical analysis. The approach to each of the components is outlined below.

Literature review

This was prepared as a background for the empirical investigation of factors that appear to influence health outcomes across countries once one has controlled for income. As a result, it is neither comprehensive nor systematic with regard to the link between health expenditure and outcomes. It is selective in two important respects. First, its scope is limited to the extent that it is biased towards literature concerned with national-level health outcomes. Secondly, the review is selective as to its sources in that the focus is very much on quantitative evidence, ignoring theoretical and qualitative contributions, and less recent work.

Empirical analysis

We examined data from 173 countries in respect of two key health-outcome measurements – life expectancy (LE) and infant mortality (IM). Infant mortality is most sensitive to changes in particular kinds of health expenditure, for example on vaccinations or maternal health, particularly in lower-income countries. Life expectancy is a good measure of the extension of life past childhood; it is less sensitive to current health expenditure and more closely reflects the full range of health system factors, including organisation, infrastructure and human resources, which contribute to the total 'health production function'.

The empirical analysis takes a four-step approach to establishing the relationships between health outcomes, national income and other key independent variables. The analysis uses standard statistical methods, with regression and time-series analyses as the main tools.

This research report comprises two chapters providing the findings of each of the methodological components. This is followed by a discussion chapter, which synthesises the findings and concludes with recommended areas for future research.

2. Literature review

This chapter provides a summary of the findings of the literature review. A full version of the review is published separately by the Oxford Policy Institute (Mai and Hay 2009). The sources of good health are multiple, complex and far from clear and have attracted much attention in the quest to improve health outcomes. As a result, a large body of literature exists with, as yet, no strong consensus on the most important sources of good health. Nonetheless, the literature does fall into four main categories and these define the structure of the review: income and health outcomes; expenditure on healthcare and its effectiveness; health sector organisation and management; and various contextual factors influencing health outcomes, including political and social organisation.

INCOME AND HEALTH OUTCOMES

There is a great deal of evidence for the dominant effect of income, personal and national, on health outcomes. The means by which this occurs is less clear – richer households may live in a healthier environment, eat better food, have access to better education and spend more on healthcare. None of these, taken separately or together, are, however, as strongly associated with better health as income itself.

The starting point for much work on the relationship between income and health has been Samuel Preston's paper (1975) 'The Changing Relation Between Mortality and Level of Economic Development', notable for the 'Preston Curve', which plots the relationship between national income and life expectancy. Two key observations are associated to the Preston curve, as demonstrated more recently (Bloom and Canning 2007).

1. There is a positive relationship between national income and life expectancy. The relationship is much stronger for lower-income countries and less sensitive to changes in higher-income countries, demonstrating diminishing returns.

2. There was a systematic upward shift of Preston's curve throughout the three decades of the previous century (1900s, 1930s and 1960s) that he examined. Over this period, life expectancy has increased at all income levels suggesting that 75–90% of the increase in life expectancy is explained by factors other than a nation's level of income.

The post-Preston literature investigates various dimensions of income and income equality as determinants of health outcomes. Wagstaff and Doorslaer (2000) summarise this into five main hypotheses.

1. The Absolute Income hypothesis states that an individual's health is a function of his/her absolute income.

There has been much interest in the impact of income inequality on health status and outcomes and the next four hypotheses are different expressions of this.

2. The Relative Income hypothesis indicates that an individual's relative, rather than absolute, income affects his/her health.

3. The Deprivation hypothesis states that the extent of deprivation that is shown by the gap below the poverty line determines health status.

4. The Relative Position hypothesis states that the individual's position in the income distribution hierarchy is key.

5. The Income Inequality hypothesis suggests that individual health is actually directly affected by income inequality.

The Absolute Income hypothesis has wide empirical support from Wagstaff and Doorslaer themselves and a range of other analysts (Rodgers 1979; Deaton 2003; Gerdtham and Johannesson 2004; Lindhal 2005). These studies confirm that high absolute income levels are, on the whole, protective of health. Nonetheless, while widely assumed, the evidence for the impact of income inequality on health is much less conclusive.

Wilkinson (1996, 1997a, 1997b, 2002) is perhaps best known for evidence that societies with relative income equality produce better health outcomes than societies with less equal income distributions. In fact, this has not been widely supported empirically. Despite this lack of strong evidence for an association between income distribution and health outcomes, Wilkinson's work has stimulated a large literature on how income inequality might affect health. These publications have tended to suggest that further investigations into the effects of broader underlying socioeconomic factors are needed.

HEALTH EXPENDITURE AND ITS EFFECTIVENESS

National expenditures on health across the world are highly unequal. Although strongly correlated with national income, they are even more unequally distributed (Tsounta 2009) than income itself. There is a widespread presumption that additional expenditure on healthcare buys better health. In fact, overall, the literature suggests a great deal of uncertainty about health expenditure as a health determinant, because a multitude of factors within the health financing and delivery system affect health outcomes.

There are a variety of methods for organising the financing of health services, from general taxation through social insurance to private out-of-pocket payments, and there has been some debate regarding the impact of different funding methods on health outcomes. In their comprehensive study of health expenditure across countries, Poullier et al. (2002) conclude that it is unconvincing to argue that any causality exists between the choice of finance source and health outcomes.

The effectiveness of health expenditure has also been suggested as a factor affecting health. Evans et al.'s study (2000) is the first to evaluate the effectiveness of healthcare systems in producing health outcomes across 191 countries. This study concluded that although efficiency tends to increase with health expenditure per capita, there is enough variation in efficiency at all levels of expenditure to suggest that there are important gains to be made from using existing resources more efficiently.

HEALTH SECTOR ORGANISATION AND MANAGEMENT

More recently, research attention has turned to the performance of health systems as a whole in improving health. Although there is an extensive public administration literature on public sector reforms, it is surprising how little comparative research exists to assess the advantages and disadvantages of alternative organisational arrangements for the health sector in terms of value for money and health outcomes. The work of Nolte and McKee (2008) is an exception, demonstrating that the institutions and incentives governing clinical behaviour may affect the effectiveness of health expenditure. In many countries, the institutions moderating clinical behaviour have been modified by administrative reforms. In general, these have taken two forms. Either local managers have been relieved, to an extent, of central controls (decentralisation, deconcentration, hospital autonomy) or clinicians have been subject to greater controls, as in health service purchasing and closer clinical scrutiny, for example through clinical governance. In general, the extent to which such reforms have generated greater productivity and better outcomes has yet to be rigorously assessed.

There has been an assumption that deficits in health assets (the health workforce and infrastructure) limit health gains. The evidence for this, particularly in relation to human resources, is mixed. There are two possible explanations for a lack of strong associations between human resources in health and health outcomes. The first relates to variations in health workers' skills and the incentives they have to apply those skills (Das and Hammer 2005). The second relates to variations in health-worker productivity.

Differences in health sector performance may go some way to explaining differences in health outcomes at the same level of income, although this remains to be demonstrated. Some sources of health-system inefficiency are evident, such as the (in some cases gross) levels of fraud and theft of government health resources (Gauthier and Wane 2008). Others are less so, and in all cases the underlying causes are complex. The fragmented evidence emerging from the literature suggests that what really drive the performance of health systems are the institutions (rules) that generate incentives for the key actors in the health policy and delivery community to align with better outcomes.

THE CONTEXT FOR HEALTH OUTCOMES

There is somewhat scant literature on the various dimensions of the political, social and environmental context that may be related to health outcomes. The impact of political organisation remains under-researched, with the hypothesis of a link between democracy and better health as yet unproven. Social relationships and their organisation are also widely held to influence health outcomes (Commission on Social Determinants of Health[3]). The evidence is conflicting but, on balance, there appears to be a positive relationship between interpersonal trust and health and a negative relationship between social isolation and health.

Some other sources of good health, such as education and living conditions, are probably mediated by income. Others, such as geography and genetics, are not or operate through intricate causal pathways. The significance of environmental factors is well recognised. The evidence of religion and personal belief on health outcomes (Sloan et al. 1999) does not demonstrate a strong association. There is also limited evidence of the impact of healthy behaviour initiatives on health gains. Research suggests that ill-health attributable to environmental factors is most evident in infectious diseases among the poor and chronic diseases among the better off. Nonetheless, attempts to quantify the extent in terms of definition and measurement have been problematic (Smith et al. 1999).

The literature pays less attention to the demand for good health and, with some exceptions, to the incentives governing the consumption of health services. There is little empirical evidence available to inform the best ways of inducing better health-seeking behaviour. There is, however, ample evidence to demonstrate that health service consumption is price sensitive: thus poor people under-consume services if they are too costly while the better off – the 'worried well' – may over-consume health care.

3. Following the World Health Organization (2010), the social determinants of health are the conditions in which people are born, grow, live, work and age, including the health system. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels, which are themselves influenced by policy choices. The social determinants of health are mostly responsible for health inequities – the unfair and avoidable differences in health status seen within and between countries.

LITERATURE REVIEW INSIGHTS

The literature review is neither comprehensive nor systematic and biased towards recent empirical, and quantitative, work. This is mainly because of the vast scope of the research question, the sources of good health. What is most striking in the literature review is the lack of conclusive evidence, although some consensus emerges with regard to:

- the relationship of both personal and national income with health (but with a lack of insight into the causal pathways)
- the decreasing marginal returns of health outcomes to rising income levels
- the lack of a consistent positive correlation between health expenditure and health outcomes, because expenditure is mediated through complex systems of financing and delivery, which in themselves affect health outcomes.

There is ample suggestive, but not conclusive, evidence that other factors have a bearing on good health:

- relative income and income inequality
- institutions and incentives governing clinical behaviour
- political organisation
- social relationships
- health assets, such as health workforce and infrastructure, with significance levels often lower than anticipated
- environmental factors
- the demand for health care, but taking into account the lack of insights into incentives governing health care consumption.

Given the strong link between income and health, one of the major outstanding questions concerns the differences in health outcomes at different levels of national income. It is possible that much of this variation can be explained by variations in the performance of health systems, given the varying degrees of constraint they face. Although there is suggestive evidence of such differences, there is little systematic explanation for them. That is the focus of the empirical investigation in this report.

3. Income and outcomes, the empirical evidence

Data from 173 countries were examined on life expectancy, infant mortality and national income (at purchasing power parity, PPP), as well of a series of additional explanatory variables in line with the literature review above, and subject to data availability. The analysis was carried out for the years 1990, 2000 and 2006 and builds on work by Andrews (2008) on indicators for good health and governance. We constructed a dataset with life expectancy and infant mortality as the health outcomes of interest. National income, which previous studies have shown to be a consistently strong driver of health outcomes, was then used as the principal control variable. Additional variables were subsequently used to test the extent to which they, in addition to income levels, explain health outcomes. More information on the data and their sources is provided in the appendices. The independent variables considered are:

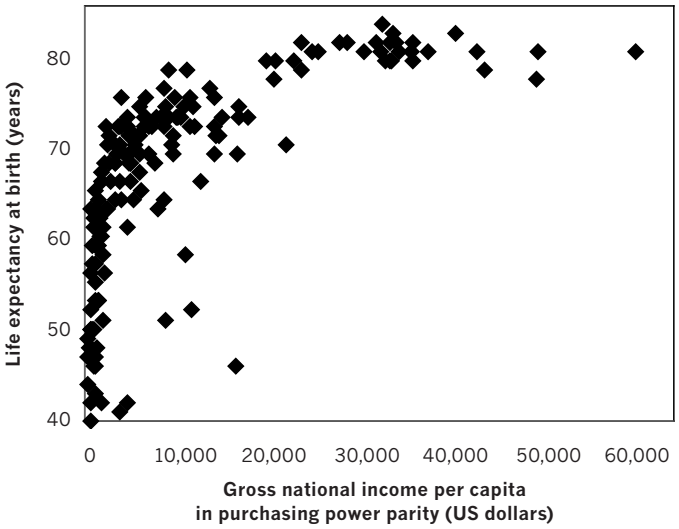
- health-sector organisation and management
- hospital beds per 10,000 population
- physician density per 10,000 population
- expenditure on healthcare
- per capita total expenditure on health PPP
- per capita government expenditure on health PPP
- per capita private expenditure on health PPP
- total expenditure on health as percentage of GDP
- public expenditure on health as percentage of GDP
- private expenditure on health as percentage of GDP
- aid per capita
- aid share of gross national income (GNI)
- health expenditure effectiveness
- effective use of resources
- Corruption Bertelsmann Transformation Index
- Corruption Perception Index
- Control of Corruption Index
- Government Effectiveness Index
- frequency of corruption
- contextual factors
- Political Stability and Absence of Violence Index
- Regulatory Quality Index
- democracy/autocracy
- urban/rural ratio
- political and social integration
- income inequality – Gini coefficient.

We have used this dataset to produce four types of analysis. First, we re-estimate the Preston curves for the years 1990, 2000 and 2006, for life expectancy and infant mortality. Second, we control for income levels and determine which countries score better and worse in terms of health outcomes expected on the basis of their income level. Then we investigate the explanatory power of the other independent variables of interest. Lastly, we look into the explanatory power of location and time.

PRESTON CURVES FOR LIFE EXPECTANCY AND INFANT MORTALITY

As discussed above, life expectancy is a key health outcome measurement and, although it is less sensitive to health expenditure than its counterpart, infant mortality, it is influenced by a wider range of factors. Figure 3.1 shows the Preston curve using cross-country data for 2006. The scatter diagram plots the relationship between national income and life expectancy. It is non-linear, rising steeply from its origin, where income is lowest and life expectancy shortest, to converge on what is a frontier of long life at high levels of income. Thus, the horizontal-axis shows gross national income per capita in purchasing power parity, the vertical-axis shows life expectancy at birth and each dot represents a particular country.

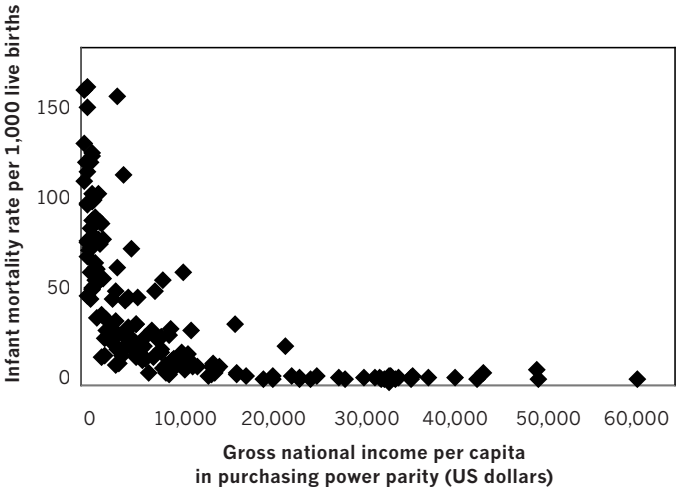
Figure 3.1: The Preston curve for life expectancy at birth in 2006



In all three years (only 2006 is shown above) the relationship between income and life expectancy flattens out with increasing levels of income. This means that in countries with low levels of income per capita, further increases in income result in large gains in life expectancy. On the other hand, in countries with high levels of income per capita, additional income has little impact on improved life expectancy. There is, therefore, a diminishing return in life expectancy in respect of additional income, with changes in income making the biggest difference in low-income countries.

Infant mortality is the second key health outcome to be examined and this indicator is more sensitive to changes in health expenditures. Again, Preston Curves have been calculated for 1990, 2000 and 2006. In Figure 3.2, the X-axis shows gross national income per capita in purchasing power parity. Purchasing power parity converts different currencies to one (in this case, the dollar) correcting for the cost of living in each country. The Y axis shows infant mortality per 1,000 live births and each dot represents a particular country, for 2006

Figure 3.2: The Preston curve of infant mortality rate in 2006



The findings of this analysis are broadly similar to those for life expectancy. Infant mortality improves more significantly in countries with low levels of income per capita than in those with high levels of income, when there is an increase of income. Again, diminishing returns of improvements in infant mortality in relation to increases in income are observed.

Visual inspection also suggests that at broadly similar levels of income both life expectancy and infant mortality vary widely, at least for low levels of income. This suggests that factors other than income are at play in determining these health outcomes.

LIFE EXPECTANCY AND INFANT MORTALITY PERFORMANCE

We can obtain a precise understanding of how a country performs in terms of health outcomes by predicting the health outcome typically associated with its income level, and then comparing this with its actual performance. We applied this procedure for both life expectancy and infant mortality. Figures 3.3 and 3.4 present the results for selected countries. For life expectancy, positive figures are performers above par whereas for the infant mortality rate the scale is inverted so positive figures are under-performers. The full results are provided in Appendices 1 and 2.

The variety in performance is considerable for both measures of health outcome. Countries such as Equatorial Guinea and Swaziland have life expectancies that are more than 20 years less (29 and 24 years respectively) than those predicted using their income level. Life expectancy in Vietnam and Eritrea is about 10 years higher than expected on the basis of their income. And a similar variation is observed for infant mortality, with bad performers (Angola, Equatorial Guinea) having over 100 more children dying than expected per 1,000 live births; the best performers (Eritrea and Vietnam) gain respectively 50 and 40 lives per 1,000 live births than anticipated on the basis of their income level. The three countries in which the ACCA ideas forums took place, Singapore, UK and US are bad performers for both outcome measures, although not dramatically so.

Figure 3.3: Predicted life expectancy compared with its actual performance, 2006

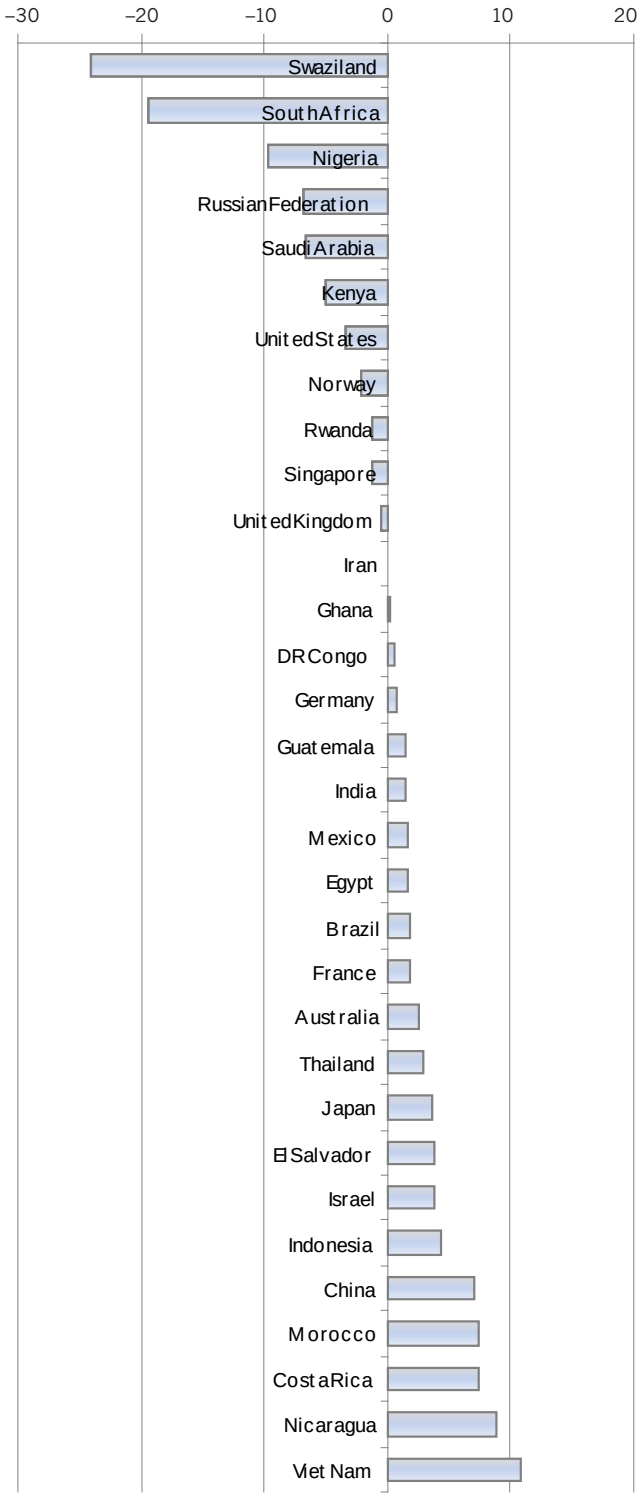
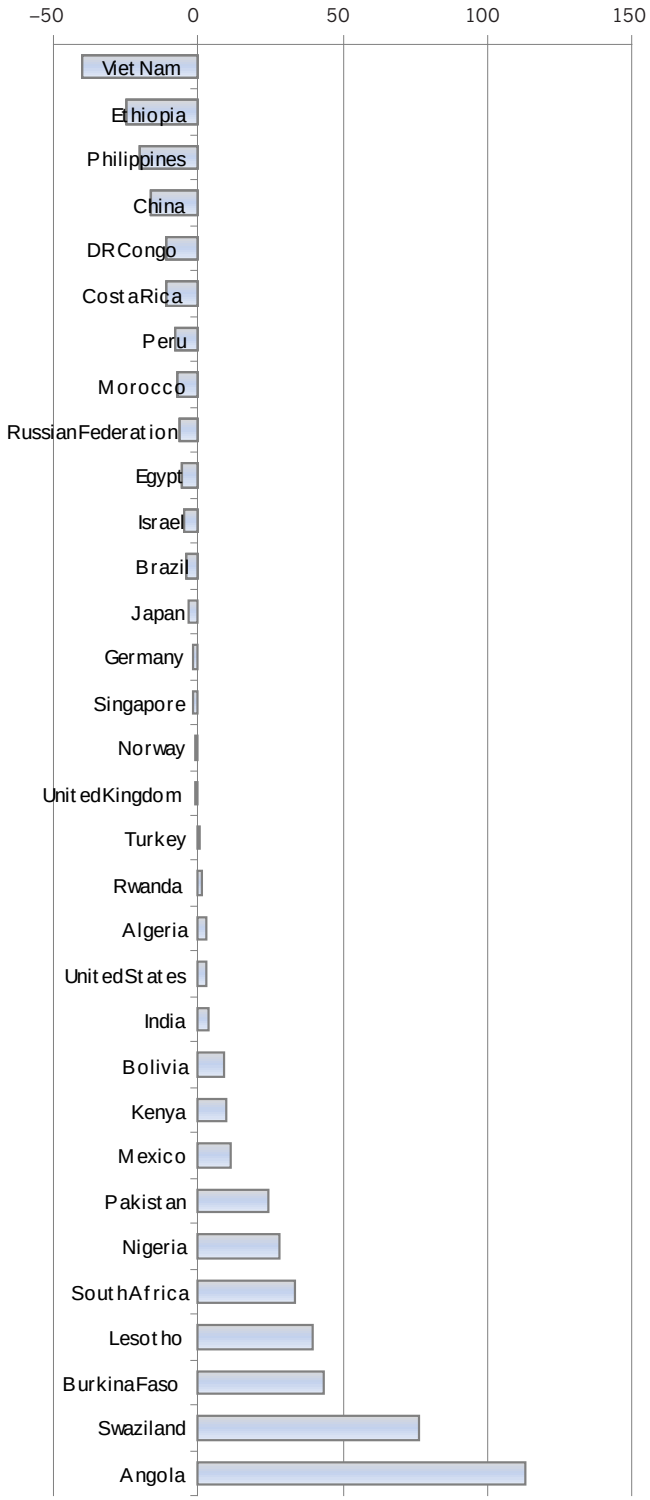


Figure 3.4: Predicted infant mortality, compared with its actual performance, 2006



Note: For life expectancy, positive figures are performers above par whereas for the infant mortality rate the scale is inverted so positive figures are under-performers. The full results are provided in Appendices 1 and 2.

We can go a step further by combining the life expectancy and infant mortality rate performance with income per capita. This is shown in the Figures 3.5 and 3.6 below and suggests that the high variation in health outcome performance is mainly concentrated in low-income countries, ie countries where income per capita is lower than USD 10,000 (in purchasing-power-parity terms). When income per capita is higher than approximately USD 10,000, the values predicted by income for both life expectancy and infant mortality rate are much closer than for countries with lower income per capita. This then suggests that factors other than income drive health outcomes in low-income countries and that the relationship between health-outcome performance and income per capita is much more stable above the USD 10,000 threshold.

Figure 3.5: Life expectancy performance by income per capita, 2006

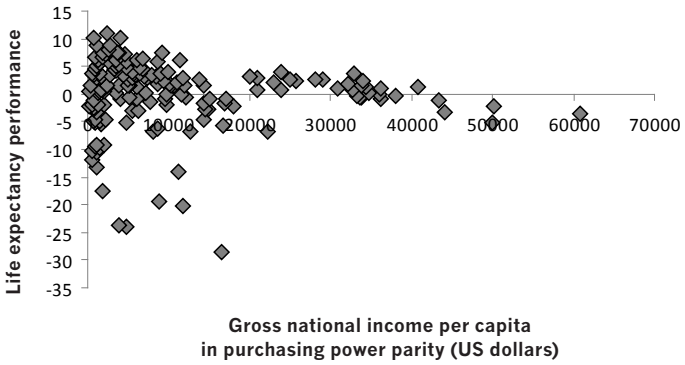
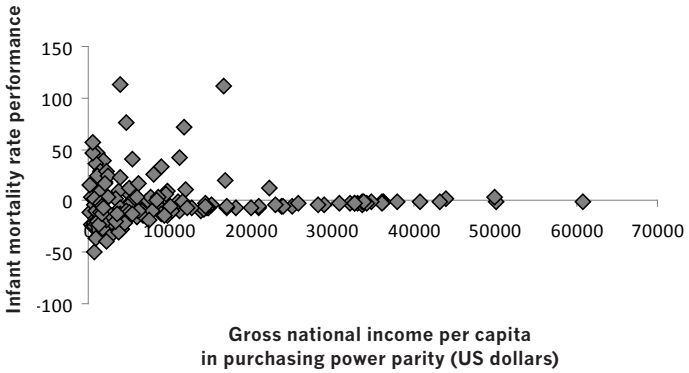


Figure 3.6: Infant mortality rate performance by income per capita, 2006



EXPLAINING HEALTH-OUTCOME PERFORMANCE

In this next step we try to explain health-outcome performance by examining the impact of the independent variables (see page 14) on health-outcome performance. We do this by looking at the variation in health outcomes that is explained by the independent variables. This measure is captured by the goodness-of-fit indicator (R-squared) of a simple regression with dependent variable, the health outcome performance, and the independent variables respectively.[4] The results are in Tables 3.1 and 3.2 for the two health outcomes of interest.

Most of the independent variables contribute to explaining health-outcome performance, but not in a significant way as most of the R-squares are lower than 5%. There is some degree of variation in the explanatory power of the same variable over time, which suggests either varying data quality or structural changes in how health outcomes are produced, or a combination of both. The best predictors, when controlling for income, are the health-sector management and organisation variables, hospital beds and physician density per 10,000 population, and this is true for both life expectancy and infant mortality rate. The number of hospital beds is especially significant, as this explains 17% of the variation in infant mortality and 16% of variation in life expectancy in 2006, and so is a relatively strong single predictor after controlling for income. This then throws up the question of what systemic aspects of the health system are embedded in a measure of hospital bed density. Interestingly, with regard to the research question, none of the health expenditure variables is a particularly good predictor of health outcomes.

4. In this set-up we examine the association between the health outcome variable (the independent variable) and a series of possible explanatory or independent variables. The technique used is simple ordinary least squares regression and the measure of association its R-square. Higher R-squares indicate better association.

Table 3.1: The correlations (R-sq) between life expectancy and each investigated variable

Variables	R-sq in 1990	R-sq in 2000	R-sq in 2006
Health-sector organisation and management			
Hospital beds per 10,000 population	0.104	0.171	0.162
Physician density per 10,000 population	0.034	0.068	0.031
Expenditure on health care			
Total expenditure per capita on health PPP	0.026	0.011	0.007
Government expenditure per capita on health PPP	0.018	0.006	0.003
Private expenditure per capita on health PPP	0.041	0.008	0.020
Total expenditure on health as percentage of GDP	0.014	0.019	0.026
Public expenditure on health as percentage of GDP	0.004	0.001	0.002
Private expenditure on health as percentage of GDP	0.014	0.046	0.049
Aid per capita	0.002	0.010	0.000
Aid share of GNI	0.014	0.005	0.001
Health expenditure effectiveness			
Effective use of resources	0.004	0.029	0.010
Corruption Bertelsmann Transformation Index	0.009	0.001	0.005
Corruption Perception index	0.013	0.027	0.012
Control of Corruption index	0.020	0.014	0.006
Government Effectiveness index	0.022	0.013	0.007
Frequency of corruption	0.009	0.006	0.011
Contextual factors			
Political Stability and Absence of Violence Index	0.033	0.002	0.004
Regulatory Quality Index	0.022	0.003	0.005
Democracy/autocracy	0.066	0.026	0.000
Urban/rural ratio	0.007	0.000	0.003
Political and social integration	0.005	0.020	0.004
Income inequality – Gini coefficient	*	*	0.006

Table 3.2: The correlations (R-sq) between infant mortality rate performance and each investigated variable

Variables	R-sq in 1990	R-sq in 2000	R-sq in 2006
Health-sector organisation and management			
Hospital beds per 10,000 population	0.112	0.166	0.174
Physician density per 10,000 population	0.024	0.066	0.045
Expenditure on health care			
Per capita total expenditure on health PPP	0.014	0.003	0.004
Per capita government expenditure on health PPP	0.015	0.002	0.002
Per capita private expenditure on health PPP	0.027	0.002	0.025
Total expenditure on health as percentage of GDP	0.007	0.012	0.039
Public expenditure on health as percentage of GDP	0.003	0.000	0.008
Private expenditure on health as percentage of GDP	0.004	0.036	0.063
Aid per capita	0.002	0.009	0.001
Aid share of GNI	0.005	0.015	0.003
Health expenditure effectiveness			
Effective use of resources	0.002	0.004	0.002
Corruption Bertelsmann Transformation Index	0.044	0.031	0.037
Corruption Perception Index	0.001	0.003	0.015
Control of Corruption Index	0.005	0.010	0.009
Government Effectiveness Index	0.014	0.012	0.015
Frequency of corruption	0.044	0.014	0.003
Contextual factors			
Political Stability and Absence of Violence Index	0.030	0.002	0.000
Regulatory Quality Index	0.028	0.013	0.012
Democracy/autocracy	0.024	0.005	0.031
Urban/rural ratio	0.001	0.000	0.001
Political and social integrate	0.000	0.002	0.000
Income inequality – Gini coefficient	*	*	0.038

THE POWER OF GEOGRAPHY AND TIME IN EXPLAINING HEALTH-OUTCOME PERFORMANCE

The analysis so far is not conclusive as to which key variables drive health outcomes, after controlling for income. The explanatory power of the variables also seems to change over time. In this section we first disaggregate the health outcome performance by region. An intuitively simple way of doing so is by mapping the health-outcome performance indicators onto a world map. Figure 3.7 and 3.8 show those for life expectancy and infant mortality rate performance for 2006.

Figure 3.7: Life expectancy performance, 2006

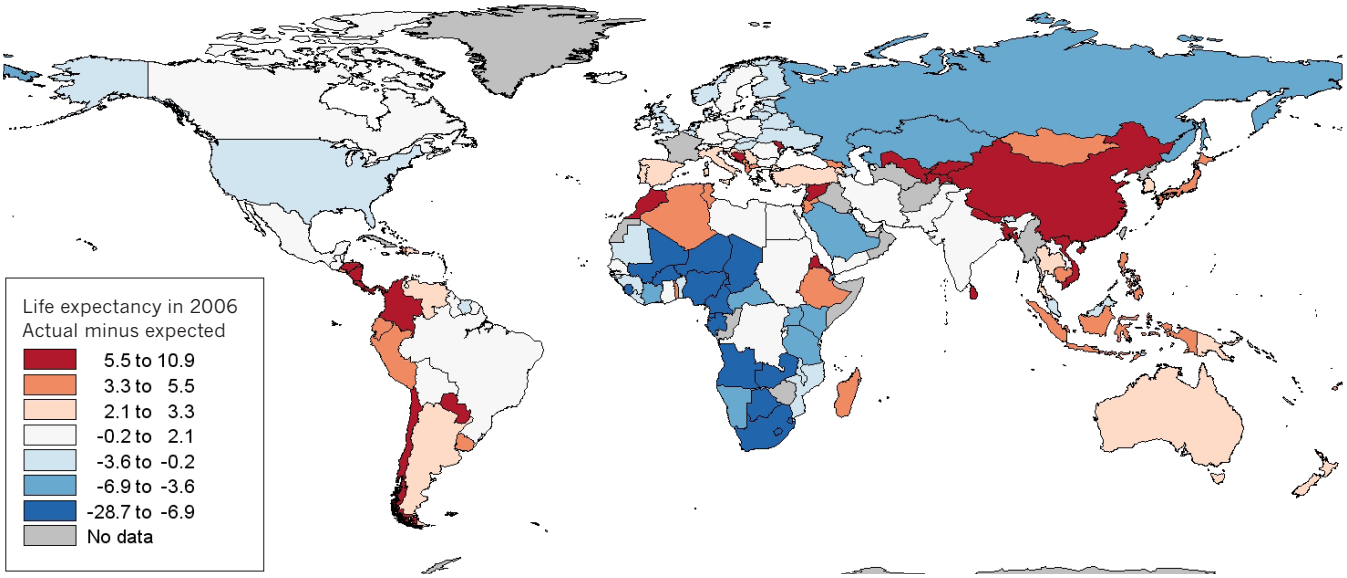
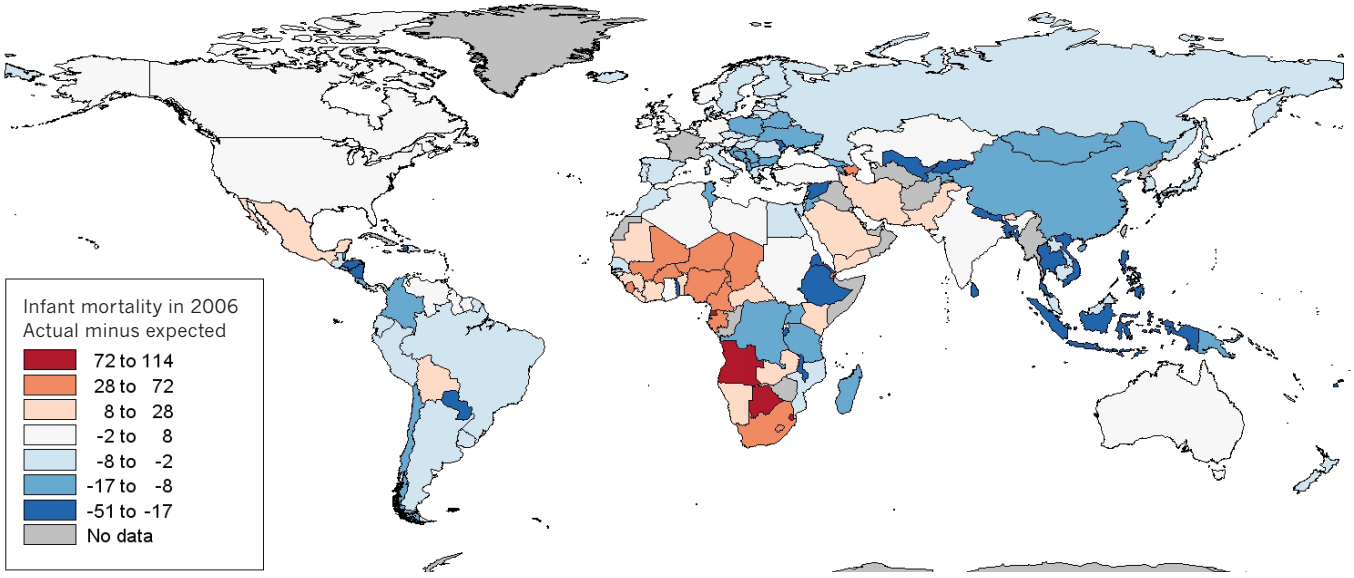


Figure 3.8: Infant mortality rate performance, 2006

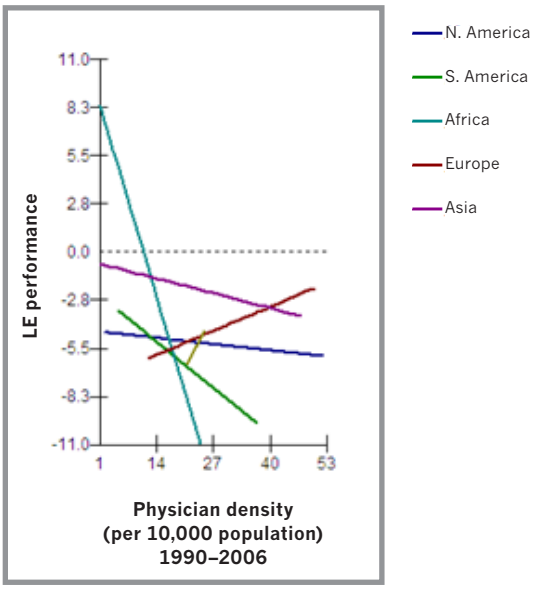


These maps confirm the data in Appendices 1 and 2, which show that Africa is a badly performing region for performance in both life expectancy and infant mortality. The apparent clustering of results by region also suggests that regions may present an interesting looking glass in which to examine the drivers of health outcomes.

This then leads on to the final elements of analysis, where we take into account time trends, regions and the effect of the independent variables of interest. As the technique for doing so is rather involved we provided some background in Appendix 3.

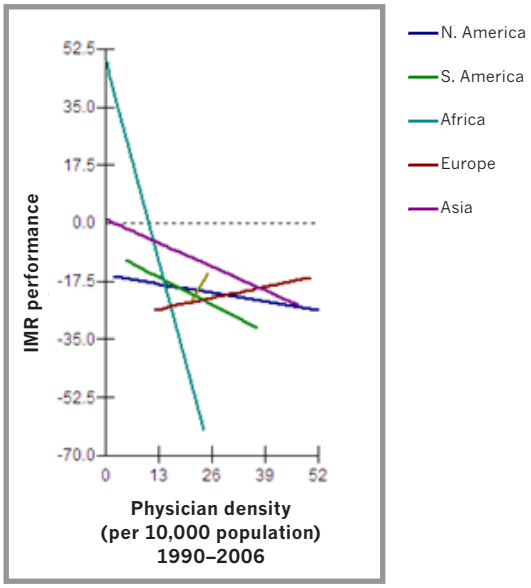
For performance in life expectancy, a positive association between health-outcome performance and a given independent variable indicates that a country performed better than would be expected from its income. For example, the positive association between life expectancy and physician density per 10,000 population for Europe indicates that increasing physician density went hand in hand with improving life expectancy performance in Europe in the period 1990–2006. This is graphically illustrated in Figure 3.9. Each line represents a region. A positive sloping line indicates a positive contribution of that independent variable to life expectancy.

Figure 3.9: The relationship between physician density and life expectancy performance over 1990–2006 in different regions



For infant mortality rates, a positive association between infant mortality rate and a given independent variable means a country performed worse than expected on the basis of its income for a specific region. For example, we obtain a positive association between infant mortality rate and physician density per 10,000 population for Europe, in other words, increasing physician density did not go hand in hand with improvements in infant mortality performance.

Figure 3.10: The relationship between physician density and infant mortality rate performance over 1990–2006 in different regions



The outcome of this analysis is shown in a series of graphs in Appendix 4 and in Tables 3.3 and 3.4. The results in the tables have the same meaning as the graphs, where independent variables have either a negative or positive contribution to life expectancy or infant mortality respectively over the period 1990–2006, by region. Statistically insignificant results (marked in bold) indicate that their contribution to the health outcome indicator is not different from zero.

Table 3.3: Summary results of multilevel regression for life expectancy

Life expectancy	North America	Europe	Africa	Asia	Australia	South America
Hospital beds per 10,000 population	P	P	N	N	N	P
Physician density per 10,000 population	N	P	N	N	P	N
Total expenditure per capita on health PPP	P	P	N	N	**N**	P
Government expenditure per capita on health PPP	P	P	N	N	**N**	P
Private expenditure per capita on health PPP	P	P	N	N	N	N
Total expenditure on health as percentage of GDP	P	N	N	N	N	N
Public expenditure on health as percentage of GDP	N	P	N	N	N	N
Private expenditure on health as percentage of GDP	P	N	N	N	**N**	N
Aid share of GNI	P	N	P	N	*	N
Effective use of resources	N	N	N	N	*	N
Corruption Bertelsmann Transformation Index	N	N	N	N	*	N
Corruption Perception Index	**P**	P	N	N	N	N
Control of Corruption Index	**P**	P	N	P	P	N
Government Effectiveness Index	**P**	P	N	**N**	P	**P**
Frequency of corruption	N	N	P	P	N	P
Political Stability and Absence of Violence Index	N	P	N	P	P	N
Regulatory Quality Index	N	P	N	P	N	P
Urban/rural ratio	N	P	N	P	N	N
Political and social integration	N	N	N	N	*	N

P: positive contribution

N: negative contribution

* : no data

Non-significant results are in bold

Table 3.4: Summary results of multilevel regression for infant mortality

Infant mortality rate	North America	Europe	Africa	Asia	Australia	South America
Hospital beds per 10,000 population	N	N	N	N	N	N
Physician density per 10,000 population	N	P	N	N	P	N
Total expenditure per capita on health PPP	P	P	P	N	P	P
Government expenditure per capita on health PPP	P	P	P	N	P	P
Private expenditure per capita on health PPP	P	P	N	N	P	P
Total expenditure on health as percentage of GDP	N	N	N	N	P	N
Public expenditure on health as percentage of GDP	N	N	N	N	P	N
Private expenditure on health as percentage of GDP	P	N	N	N	P	N
Aid share of GNI	P	**N**	P	**P**	*	P
Effective use of resources	N	N	N	N	*	N
Corruption Bertelsmann Transformation Index	N	N	N	N	*	N
Corruption Perception Index	N	P	N	N	P	N
Control of Corruption Index	N	P	N	P	P	N
Government Effectiveness Index	**P**	P	P	P	P	P
Frequency of corruption	N	N	P	P	*	P
Political Stability and Absence of Violence Index	N	P	N	P	**P**	N
Regulatory Quality Index	N	P	N	**N**	P	P
Urban/rural ratio	P	P	**P**	P	P	N
Political and social integration	N	N	N	N	*	N

P: positive contribution

N: negative contribution

* : no data

Non-significant results are in bold

This analysis yields the following insights. First, we find that the explanatory power of the regional effects is very stark, and often explained up to an additional 50% of the variance in the performance on life expectancy and infant mortality. This suggests that examining the drivers of health outcomes at a cross-country level suffers from some form of regression to the mean, which is that meaningful relationships between variables are obscured by aggregating results over too many essentially different populations or healthcare systems. This finding also emerged from the ideas forum in the US. Conversely, it suggests that between-region differences are sufficiently large to warrant the study of the drivers of good health to be carried out at regional level. This presents the challenge of determining what 'sufficiently homogeneous regions' are, and under which conditions insights from one region can be applied elsewhere. Secondly, the analysis shows that the same independent variable, say physician density, will have a different explanatory power with regard to health-outcome performance by region. The contribution may not even be in the same direction, that is that sometimes the association will be positive, sometimes negative. This confirms that meaningful insights with regard to the drivers of health outcomes (after controlling for income) are best sought at the regional level.

4. Discussion

As shown by the re-estimated Preston curves (Figures 3.1 and 3.2, pages 14 and 15), national income has a dominant impact on health outcomes as measured by life expectancy and infant mortality rates, and this is true across the world. Nonetheless, after controlling for income, there remain significant variations between actual life expectancy and what would be expected purely on the basis of income. The same observation is made for infant mortality rates. The variation, however, mainly occurs in countries with incomes lower than USD 10,000 per capita.

Conversely, in countries with higher income levels, the disparity in actual health outcomes and those predicted by income are much smaller. In other words, in richer countries, factors other than income do not seem to be significant drivers of health outcomes, at least in comparison with poorer countries. A dividing line between rich and poor countries coincides, approximately, with the point in the Preston curves after which the returns of additional national income in the form of gains in life expectancy and infant mortality are becoming ever more marginal. This is the case for Singapore, the UK and the US. The analysis suggests that no country beyond this turning point has yet found ways of breaking out of the health-outcome path dependency dictated by its income level.

The research question as to what drives health outcomes other than income levels is thus mainly applicable to countries with income levels lower than USD 10,000 per capita. Interestingly, with regard to the initial research question, health expenditure (expressed in a variety of ways) does explain health outcomes but less so than the density of physicians and hospital beds. But broadly speaking, the analysis suggests that there are no clear and observable predictors of good or poor performance, other than geographical location. The unexplained differences between regions persist when the data are analysed across time, although actual outcomes converge on or diverge from expected outcomes at different rates with time.

The key issue, then, is the factors that are represented by geographical location. These may include issues that are largely outside the remit of the health system, such as genetic endowment, dietary and epidemiological realities unique to the regions in question. Moreover, it may be that the performance of the health system shows levels of similarity over geographic regions and thus explains the relative homogeneity in health-outcome performance over regions. In addition, the performance of health systems is amenable to policy interventions, arguably more so than the factors outside the remit of the health system. Such evidence as exists suggests that differences in performance may arise from differences in the institutions (rules) supporting the alignment and restraining the misalignment of service provider and citizens' interests. This suggests a need for further enquiry into the political economy of healthcare and a broader examination of the institutional arrangements governing political, social and economic transactions in different societies.

This technically challenging research agenda remains to be tackled in a systematic, coherent way. It seems that a plausible way forward might be to undertake pilot studies of health performance based on enhanced methodologies that incorporate differences in institutions and politician/manager/provider/consumer motivations in a few selected high- and low-performing countries.

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Appendix 1: life expectancy performance

Country	1990	2000	2006
Albania	2.5215	2.0693	3.3512
Algeria	–0.9806	2.4009	3.42
Angola	–20.214	–19.66	–23.681
Antigua and Barbuda	–1.1218	–1.0465	–0.9835
Argentina	2.9046	2.0086	2.7949
Armenia	2.0888	7.6378	2.6687
Australia	2.2025	2.7972	2.4833
Austria	0.7646	0.5589	0.0721
Azerbaijan		0.4914	–2.9652
Bahrain	–0.7338	–3.7703	6.2048
Bangladesh	4.2332	6.4191	
Belarus	2.5367	0.296	–1.9388
Belgium	0.9342	0.7003	–0.5006
Belize	7.3472	0.912	0.2176
Benin	–3.2244	–3.5992	–1.9057
Bhutan	–5.8488	–2.0628	–0.8719
Bolivia	–5.0915	–2.1788	1.4614
Bosnia and Herzegovina		5.7785	6.5141
Botswana	–2.6422	–21.53	–20.24
Brazil	–2.0152	–0.4805	1.8064
Brunei Darussalam	–5.1463	–2.8444	–5.1565
Bulgaria	2.0079	2.3338	1.6701
Burkina Faso	–3.1486	–6.3581	–9.2144
Burundi	3.1069	3.1242	1.4264
Cambodia	–4.2634	3.0963	3.6211
Cameroon	1.8083	–8.036	–9.3271
Canada		1.6121	1.0266
Cape Verde	8.6466	7.2994	8.1049
Central African Republic	–0.0329	–4.3075	–4.836
Chad	–4.8315	–6.8926	–10.453
Chile	3.6956	4.9526	6.0156
China	12.929	7.7734	7.0822
Colombia	1.4613	2.9733	6.2044
Comoros	2.064	6.0162	8.7252
Congo	–2.8745	–7.4503	
Costa Rica	8.1474	6.9002	7.4088
Cote D'Ivoire (Ivory Coast)	–4.2797	–6.4913	–5.5102
Croatia	0.41	1.9774	2.6219
Cyprus	2.1218	1.2236	2.5607
Czech Republic		0.4508	0.7973
Denmark	–0.0638	–0.3561	–0.9563
Djibouti		–5.2931	–4.7148
Dominica	5.2521	4.9468	2.8851
Dominican Republic	1.4967	2.9154	

Country	1990	2000	2006
DR Congo	–0.2957	5.3628	0.59
East Timor	0.2911	–3.4177	–0.5358
Ecuador		2.2347	4.4839
Egypt	–1.8883	–0.6098	1.6825
El Salvador	–0.3354	2.0735	3.8115
Equatorial Guinea	–8.2634	–22.1	–28.627
Eritrea	–1.1288	8.9897	10.264
Estonia		–1.2409	–2.2072
Ethiopia	2.1069	4.281	3.787
Fiji		1.7697	3.398
Finland	0.3172	1.2314	–0.3596
France	1.9423	1.8627	1.8352
Gabon	–10.493	–12.841	–13.911
Gambia	0.9044	1.8883	2.9079
Georgia	0.6129	7.3838	5.3367
Germany	–0.0859	0.8975	0.7424
Ghana	5.4786	2.9916	0.1494
Greece	2.6122	1.6955	1.1326
Grenada	–3.3178	–3.7514	1.4374
Guatemala	–2.5014	–1.5683	
Guinea	–8.1302	–4.3142	–3.2144
Guinea Bissau	–5.0422	–1.719	–2.0591
Guyana	1.9286	–4.1003	0.2211
Haiti	–4.3113	0.3771	5.1592
Honduras	3.8268	2.8717	6.201
Hungary	–2.8419	–1.3432	–1.7695
Iceland	2.9041	2.8567	1.5238
India	2.2712	1.2857	1.4576
Indonesia	–0.1515	3.0375	4.4249
Iran	–5.3178	–2.463	–0.009
Ireland	1.7266	–0.8726	0.3257
Israel	3.4318	2.2377	3.9025
Italy	2.2002	2.1689	2.5677
Jamaica	2.5162	2.5658	3.2467
Japan	3.7949	3.9436	3.7089
Jordan	3.2691	4.3039	4.851
Kazakhstan	–4.0498	–4.8538	–6.1936
Kenya	3.8414	–4.4744	–5.016
Kiribati	–5.4417	–4.303	–2.9065
Korea, Republic of	0.7135	1.1634	2.1511
Kuwait		–2.5055	
Kyrgyzstan	3.0365	6.8113	6.6351
Laos, Peoples Democratic Rep.	–2.2244	–0.1203	0.8292
Latvia	–1.0795	–0.1381	–2.8509

Country	1990	2000	2006
Lebanon	–1.4109	–2.0386	–0.8678
Lesotho	2.43	–8.7133	–17.441
Liberia		0.6017	–2.1515
Libyan Arab Jamahiriya			–0.1816
Lithuania	–1.1155	0.7497	–2.7158
Luxembourg	–1.6993	–1.2744	–3.5174
Macedonia (former Yugoslavia)	2.2906	2.2017	3.5105
Madagascar	–0.5583	2.3508	4.5764
Malawi	–2.2776	–3.7021	–2.836
Malaysia	1.5237	–0.7001	–0.4868
Maldives		2.2348	5.9656
Mali	–8.3331	–7.6492	–9.3774
Malta	3.1719	2.558	2.7745
Marshall Islands		–11.123	–6.6533
Mauritania	–1.7108	–1.3192	–2.0211
Mauritius	1.2825	–0.0309	1.4277
Mexico	–0.3249	0.6598	1.6096
Micronesia (Federated States of)		–2.0298	1.2717
Moldova, Republic of	2.8606	9.4143	5.9222
Mongolia	1.5183	2.8542	3.5465
Montenegro		5.1973	3.6277
Morocco	2.5841	6.0996	7.3721
Mozambique	0.1356	0.9768	–2.5316
Myanmar	13.781	9.0368	
Namibia	–1.4504	–5.1711	–5.0776
Nepal	3.2332	5.7557	6.5545
Netherlands	1.8198	0.316	–0.2798
New Zealand	1.2109	3.35	2.3746
Nicaragua	6.4648	9.8637	8.7695
Niger	–16.367	–9.9632	–10.213
Nigeria	–9.623	–9.4285	–9.7306
Norway	1.1778	0.4661	–2.1797
Oman	–2.5453	–1.5225	
Pakistan	–1.1169	0.3147	1.5982
Palau			–4.6162
Panama	5.6949	6.005	5.8143
Papua New Guinea	0.586	0.964	3.2764
Paraguay	7.5455	8.2397	10.06
Peru	1.0506	0.6838	4.8135
Philippines	3.2978	3.3062	4.181
Poland	1.5658	1.2839	1.4269
Portugal	0.9806	1.6763	3.1191
Romania	0.3303	1.2826	1.7506
Russian Federation	–3.1423	–5.9763	–6.8059

Country	1990	2000	2006
Rwanda	–0.1599	–4.3408	–1.222
Saint Lucia	2.2098	3.3484	
Samoa	–4.154	0.539	1.4777
Sao Tome and Principe			2.8915
Saudi Arabia	–6.2481	–5.4056	–6.6402
Senegal	–1.5254	–0.9816	0.577
Serbia		2.4379	2.3349
Seychelles	–2.6698	–2.1572	–1.6257
Sierra Leone	–11.278	–8.535	–11.992
Singapore	0.0797	0.0662	–1.1848
Slovakia	–1.1209	–0.1716	–0.8057
Slovenia		0.7194	0.8652
Solomon Islands	0.6265	4.7576	7.4093
South Africa	–6.3706	–12.137	–19.349
Spain	2.9046	2.5843	2.7522
Sri Lanka	7.0199	5.3062	7.6068
St Kitts and Nevis	–3.1236	–2.6949	
St Vincent	4.9442	1.4093	
Sudan	4.5819	2.4008	0.6735
Suriname	–1.6717	–0.6034	–1.3751
Swaziland	–6.3229	–15.896	–23.976
Sweden	–4.9795	2.9732	1.409
Switzerland	0.8595	1.9747	1.2158
Syrian Arab Republic	4.016	5.5907	6.9423
Tajikistan	–3.5033	6.5297	5.577
Tanzania, United Republic of	–0.1486	–3.7338	–5.239
Thailand	3.4521	1.4605	2.8779
Togo	2.6382	3.4058	3.4127
Tonga	2.0123	1.7168	3.9846
Trinidad and Tobago	–0.3277	–2.7268	–5.7005
Tunisia	1.8856	3.0879	3.8135
Turkey	–2.778	0.2928	3.0386
Uganda	1.9678	–6.4521	–4.5019
Ukraine	0.0785	1.5456	–0.7733
United Arab Emirates	–3.4145	–1.2248	–0.458
United Kingdom	1.3219	1.0735	–3.3055
United States	–0.8809	–1.2342	
Uruguay	3.2464	3.7868	3.8938
Uzbekistan		6.6808	7.2538
Vanuatu	–1.4504	1.5009	5.0819
Venezuela	1.3784	1.3672	2.2185
Vietnam	13.479	10.857	10.888
Yemen	–3.2471	–0.8733	0.5739
Zambia	–3.1844	–12.904	–13.275

Appendix 2: infant mortality rate performance

Country	1990	2000	2006
Albania	–14.164	–14.312	–15.272
Algeria	13.684	3.1632	2.509
Angola	92.856	96.891	113.49
Antigua and Barbuda	2.0284	–2.6719	–3.909
Argentina	–7.3426	–1.8482	–3.747
Armenia	–11.058	–22.224	–13.616
Australia	–0.7302	–0.8277	–0.741
Austria	0.8321	–0.4512	–1.362
Azerbaijan		23.373	40.514
Bahrain	2.3242	3.42	–23.71
Bangladesh	–13.135	–21.609	
Belarus	–22.003	–20.844	–14.839
Belgium	0.2319	–0.6712	–1.757
Belize	–6.7248	–8.4874	–12.794
Benin	13.775	16.322	12.863
Bhutan	30.798	25.621	23.195
Bolivia	31.739	20.009	8.954
Bosnia and Herzegovina		–17.572	–14.681
Botswana	11.752	53.701	72.335
Brazil	16.321	3.282	–3.799
Brunei Darussalam	8.9459	4.0817	4.143
Bulgaria	–17.776	–12.477	–9.852
Burkina Faso	11.628	27.395	43.24
Burundi	–17.118	–23.498	–22.583
Cambodia	15.156	–8.1698	–2.71
Cameroon	–0.3219	24.114	28.488
Canada		–0.5328	–0.322
Cape Verde	–33.437	–25.94	–26.622
Central African Republic	5.7075	21.143	16.245
Chad	20.975	31.308	46.499
Chile	–16.675	–8.6746	–10.264
China	–56.353	–20.718	–16.046
Colombia	–16.216	–12.276	–12.808
Comoros	–1.4051	–19.383	–27.441
Congo	8.7802	16.026	
Costa Rica	–20.591	–11.997	–10.741
Cote D'Ivoire (Ivory Coast)	27.229	28.809	22.932
Croatia	–11.078	–11.751	–10.149
Cyprus	–1.1296	–3.5983	–5.138
Czech Republic		–7.5417	–6.947
Denmark	–0.7753	–0.5824	–2.337
Djibouti		34.197	29.235
Dominica	–22.037	–13.61	–6.993
Dominican Republic	–5.4454	–2.7385	

Country	1990	2000	2006
DR Congo	4.4103	–23.894	–10.76
East Timor	1.5165	35.05	13.08
Ecuador		–6.228	–6.59
Egypt	13.249	2.4844	–5.663
El Salvador	–0.4245	–3.6402	–9.753
Equatorial Guinea	33.156	95.003	111.33
Eritrea	–10.943	–38.21	–50.349
Estonia		–9.079	–6.611
Ethiopia	–9.1178	–22.385	–24.49
Fiji		–22.951	–21.159
Finland	–3.1464	–2.5831	–2.894
France	–0.7969	–1.9361	–2.09
Gabon	42.519	43.726	41.562
Gambia	5.1855	7.7555	4.589
Georgia	0.4242	–21.189	–12.58
Germany	–0.6966	–1.9946	–1.996
Ghana	–29.043	–13.704	0.578
Greece	–1.2273	–1.4794	–2.404
Grenada	–4.6177	–1.8197	
Guatemala	13.297	5.0502	–2.83
Guinea	36.756	26.655	19.24
Guinea Bissau	20.877	14.615	4.038
Guyana	–20.242	4.7744	2.048
Haiti	30.881	4.7867	–20.757
Honduras	–16.326	–15.114	–20.874
Hungary	–5.0666	–5.817	–6.401
Iceland	–2.6611	–2.926	–3.78
India	–8.3496	0.7545	3.868
Indonesia	–10.346	–15.784	–18.75
Iran	19.382	12.224	9.34
Ireland	–6.4363	–0.3944	–1.592
Israel	–3.3057	–2.6294	–4.609
Italy	–0.7221	–1.4691	–3.892
Jamaica	–11.163	–0.2789	–0.88
Japan	–2.2747	–3.0728	–2.962
Jordan	–21.443	–15.992	–14.242
Kazakhstan	18.466	4.0951	3.201
Kenya	–19.847	2.1418	9.498
Kiribati	22.366	24.265	17.539
Korea, Republic of	–14.303	–5.8136	–3.966
Kuwait		4.8358	
Kyrgyzstan	0.7422	–27.767	–26.966
Laos, Peoples Democratic Rep.	22.775	4.9386	–4.886
Latvia	–9.1435	–10.556	–6.175

Country	1990	2000	2006
Lebanon	–1.224	7.1211	5.979
Lesotho	3.5406	16.489	39.392
Liberia		17.438	15.389
Libyan Arab Jamahiriya			–0.802
Lithuania	–8.9747	–13.193	–7.449
Luxembourg	5.6586	0.2492	–0.393
Macedonia (former Yugoslavia)	4.221	–12.024	–9.746
Madagascar	2.722	–7.7864	–16.564
Malawi	10.969	–5.6162	–21.755
Malaysia	–17.948	–8.7592	–7.099
Maldives		–1.6042	–9.639
Mali	29.48	32.214	35.732
Malta	–6.1644	–3.3557	–4.911
Marshall Islands		33.395	25.715
Mauritania	8.1758	12.077	18.09
Mauritius	–16.166	–5.9041	–7.255
Mexico	15.768	14.224	11.681
Micronesia (Federated States of)		8.3084	2.979
Moldova, Republic of	–18.278	–49.058	–34.85
Mongolia	11.134	–11.237	–14.28
Montenegro		–17.493	–13.32
Morocco	8.7503	–3.0201	–6.712
Mozambique	17.409	4.3654	–3.571
Myanmar	–57.299	–30.609	
Namibia	8.7134	10.825	9.511
Nepal	–14.135	–25.115	–36.896
Netherlands	–0.3626	–0.0977	–1.063
New Zealand	–3.466	–2.8803	–2.89
Nicaragua	–16.627	–21.148	–21.208
Niger	76.016	50.391	46.51
Nigeria	29.168	27.573	28.071
Norway	1.8523	–0.1402	–0.846
Oman	7.7265	0.3896	
Pakistan	25.006	23.842	24.26
Palau			–4.653
Panama	–12.926	–5.3528	–4.82
Papua New Guinea	–13.688	–3.8856	–12.031
Paraguay	–13.907	–17.745	–20.554
Peru	13.24	1.7695	–7.593
Philippines	–22.42	–18.844	–19.796
Poland	–13.926	–8.6443	–8.742
Portugal	–4.4193	–3.6322	–7.464
Romania	–5.9441	–7.3012	–6.053
Russian Federation	–1.8681	–6.082	–6.384

Country	1990	2000	2006
Rwanda	–9.9426	3.1347	1.523
Saint Lucia	–14.624	–9.1493	
Samoa	0.4268	–10.077	–10.966
Sao Tome and Principe			–6.043
Saudi Arabia	24.256	13.56	11.726
Senegal	–14.722	–6.6602	–7.495
Serbia		–15.836	–14.547
Seychelles	–3.7569	0.4309	–2.634
Sierra Leone	48.969	32.636	56.168
Singapore	–1.2881	–1.7688	–1.399
Slovakia	–6.9533	–7.3093	–5.334
Slovenia		–4.7338	–5.557
Solomon Islands	15.649	0.9841	–6.906
South Africa	14.809	25.13	33.619
Spain	–4.3137	–3.2567	–3.109
Sri Lanka	–45.114	–32.844	–30.594
St Kitts and Nevis	2.9374	4.2925	
St Vincent	–24.3	–11.247	
Sudan	–26.921	–13.678	–1.148
Suriname	–2.3616	0.798	3.929
Swaziland	34.854	61.558	76.159
Sweden	–2.0759	–3.1235	–2.67
Switzerland	2.9051	0.3425	–0.674
Syrian Arab Republic	–27.736	–25.097	–27.123
Tajikistan	35.555	–13.103	–11.494
Tanzania, United Republic of	–9.3719	–7.9211	–10.026
Thailand	–20.501	–19.43	–18.798
Togo	–17.778	–18.555	–24.347
Tonga	–21.939	–13.001	–12.32
Trinidad and Tobago	–0.3704	10.325	20.472
Tunisia	–7.3865	–7.6928	–9.592
Turkey	30.091	11.664	0.569
Uganda	–32.815	–12.2	–10.123
Ukraine	–5.8987	–22.923	–9.879
United Arab Emirates	9.7819	3.2082	
United Kingdom	–1.1635	–0.2984	–0.798
United States	5.0489	2.5764	2.678
Uruguay	–10.778	–7.3129	–7.413
Uzbekistan		–14.923	–18.625
Vanuatu	–3.2866	–3.7505	–13.412
Venezuela	1.9873	1.028	–0.748
Vietnam	–67.043	–44.675	–40.008
Yemen	23.592	20.628	16.937
Zambia	8.1665	15.83	23.559

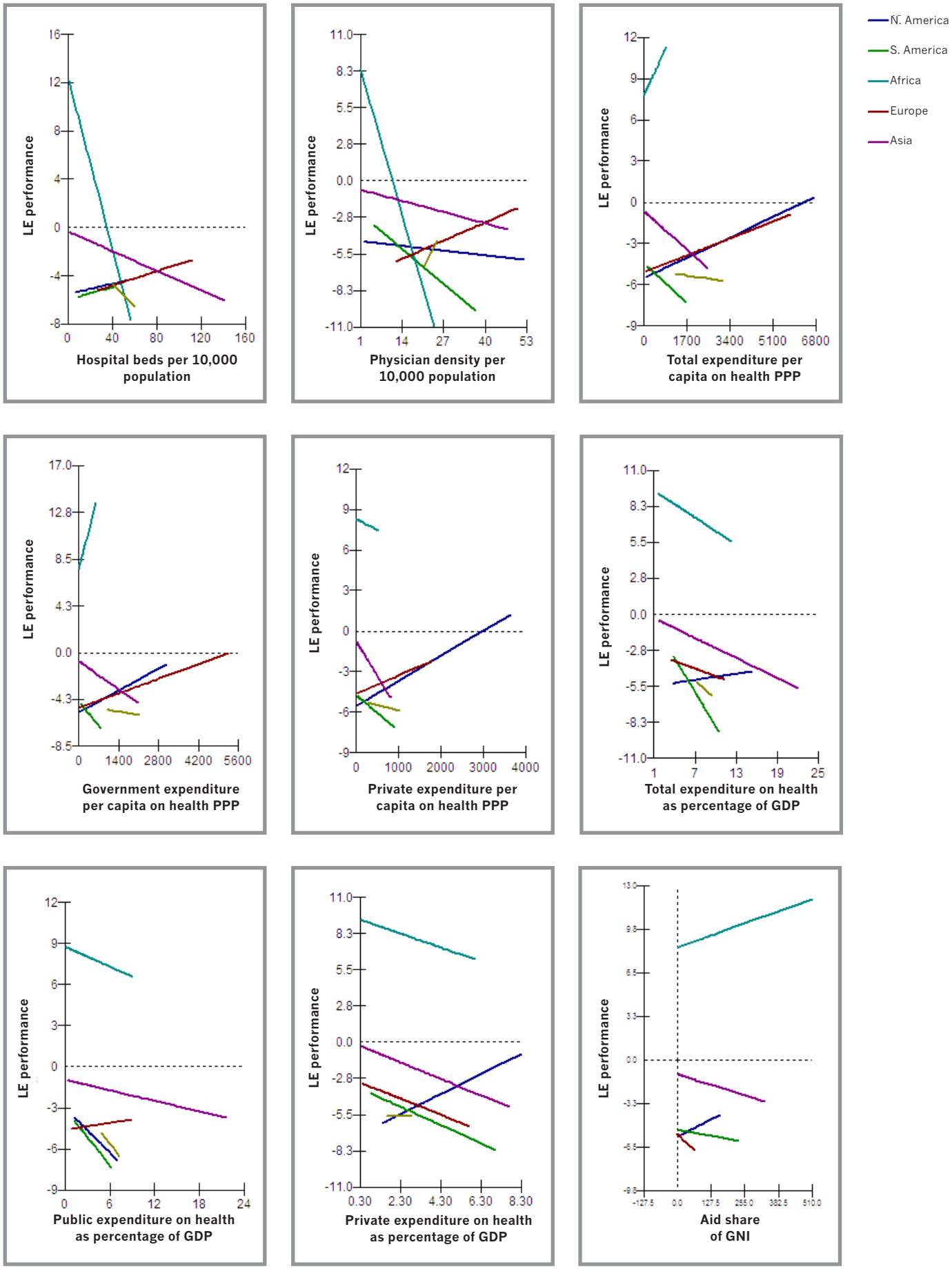
Appendix 3: technical note on multilevel regression model

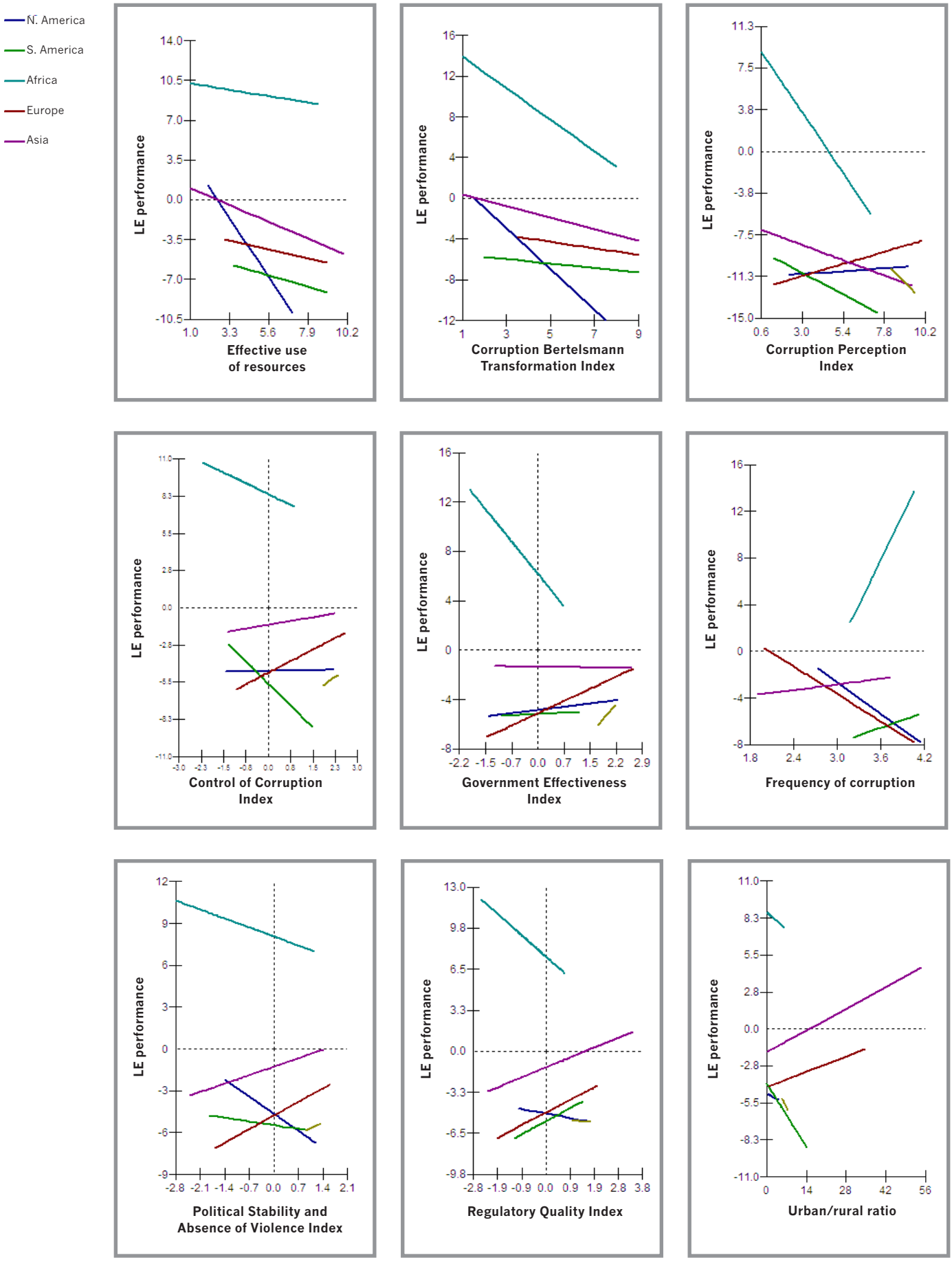
We ran a multilevel regression model that assesses the performance of life expectancy and infant mortality over time, and per region. Time trends are incorporated whenever data were available for all three years, and the region effect was captured by allocating each of the 173 countries studied into one of the following regions: North America, South America, Africa, Europe, Asia and Australia. We opted to apply multilevel regression modelling because there is a hierarchical structure in the combined dataset in the life expectancy at birth/infant mortality rate measurements as data time points are nested within each country (ie for each country we have a number of separate observations, for the various years, although some years may be missing, leading to imbalance in the data). Multilevel regression modelling can deal with both the imbalance and hierarchical structure. It can also deal with the need to model variation between regions and years simultaneously to get an adequate description of the trends in different regions. Failing to take account of the data structure might lead to inaccurate and biased estimation.

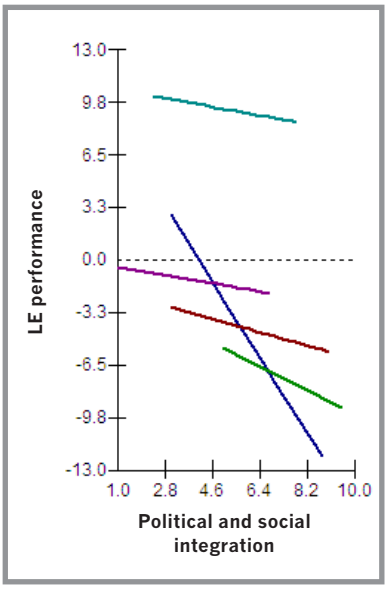
We modelled the relationship between health-outcome performance and each independent variable of interest (see list on page 14) within the different regions. To do this, we deducted actual life expectancy from predicted life expectancy. We predicted the infant mortality rate from actual rate. In this way we were able not only to investigate the degree of association between health outcomes and independent variables after controlling for income but also to see how much the regional effects explained away the variation of health outcome performance. This allowed us to gain an insight in how the predicted health-outcome performance per region is explained by the different independent variables.

Appendix 4: multilevel regression analysis

LIFE EXPECTANCY PERFORMANCE BY REGION AND EXPLANATORY VARIABLE

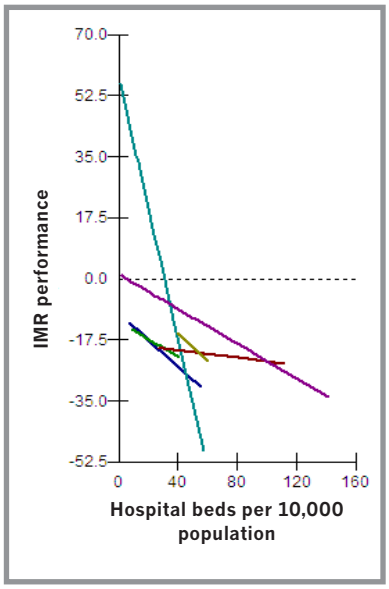


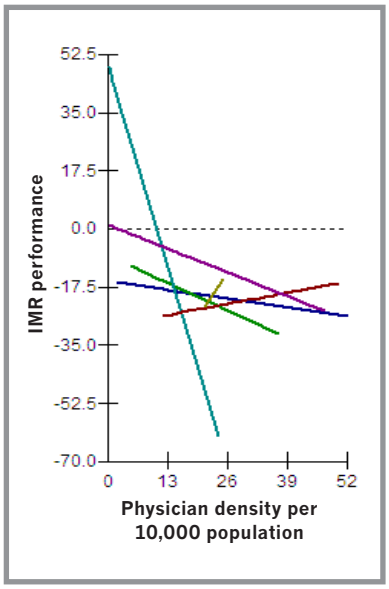

N. America
S. America
Africa
Europe
Asia
LE performance
Effective use of resources
Corruption Bertelsmann Transformation Index
Corruption Perception Index
Control of Corruption Index
Government Effectiveness Index
Frequency of corruption
Political Stability and Absence of Violence Index
Regulatory Quality Index
Urban/rural ratio

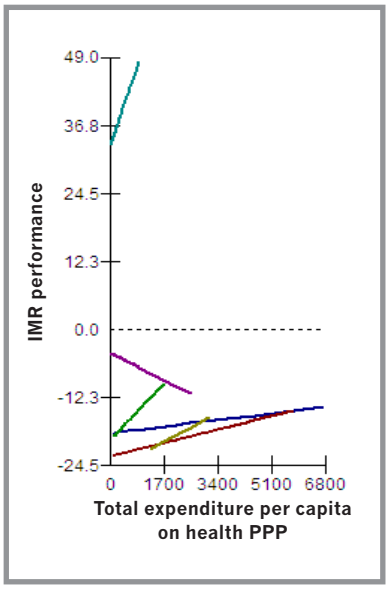

13.0
9.8
6.5
3.3
0.0
-3.3
-6.5
-9.8
-13.0
LE performance
1.0
2.8
4.6
6.4
8.2
10.0
Political and social integration
N. America
S. America
Africa
Europe
Asia

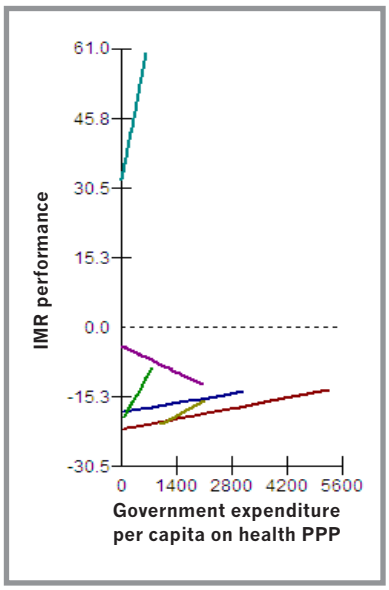
INFANT MORTALITY PERFORMANCE BY REGION AND EXPLANATORY VARIABLE

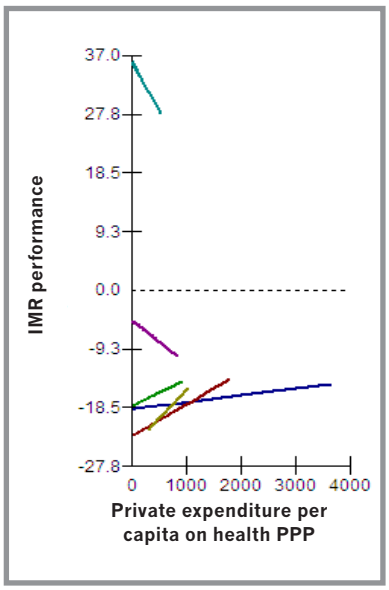
N. America
S. America
Africa
Europe
Asia

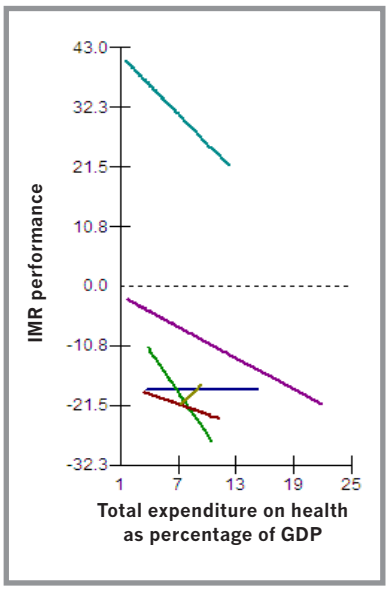


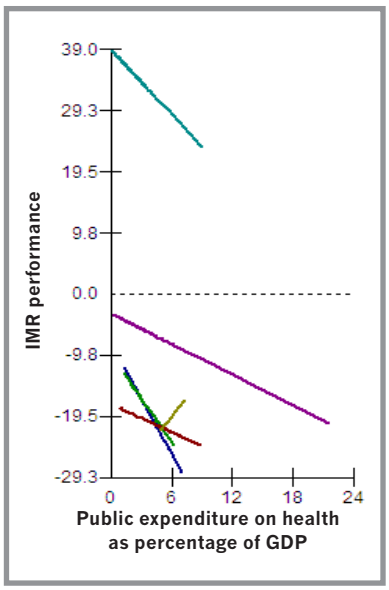


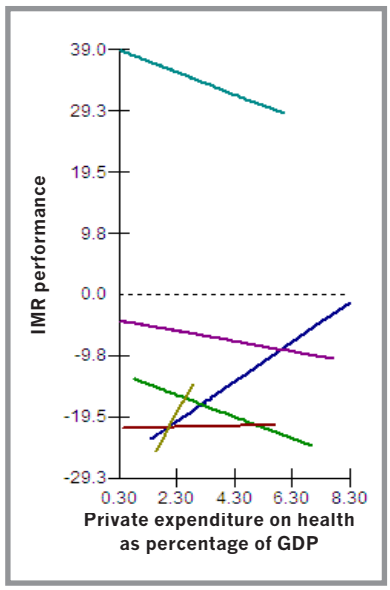


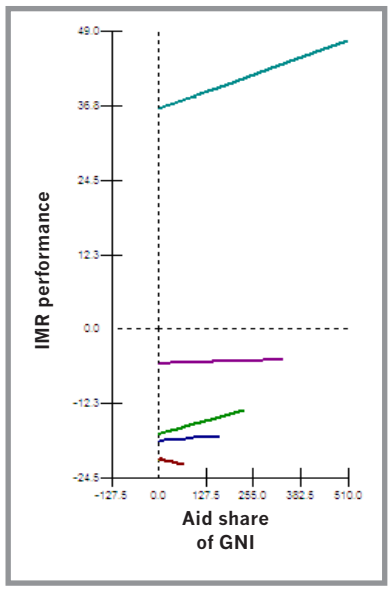


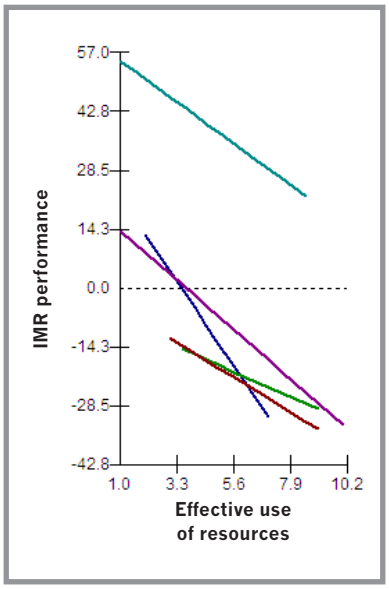


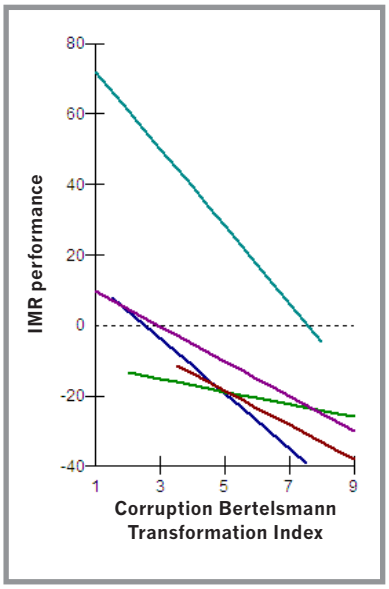


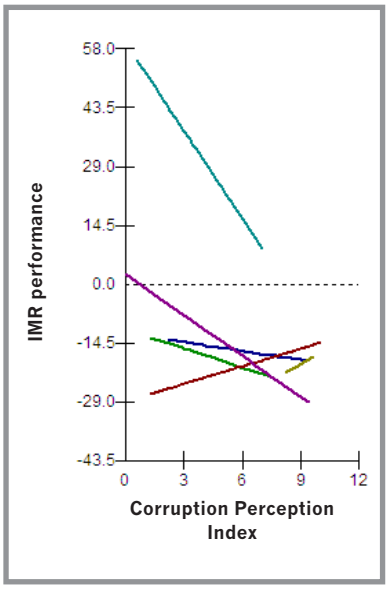




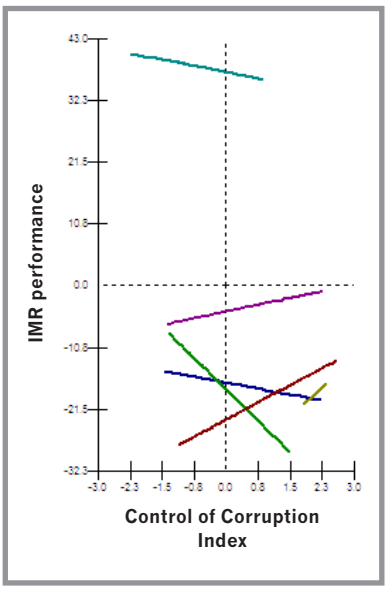


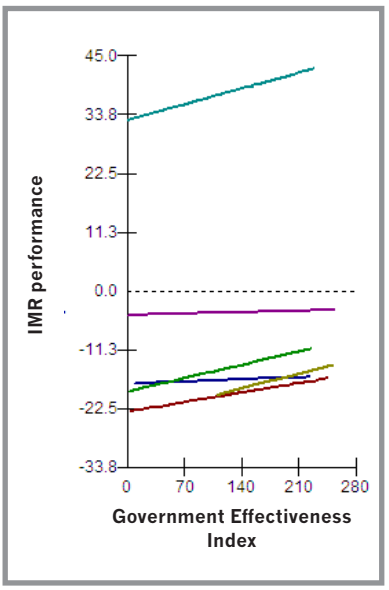

IMR performance
57.0
42.8
28.5
14.3
0.0
-14.3
-28.5
-42.8
1.0
3.3
5.6
7.9
10.2
Effective use of resources

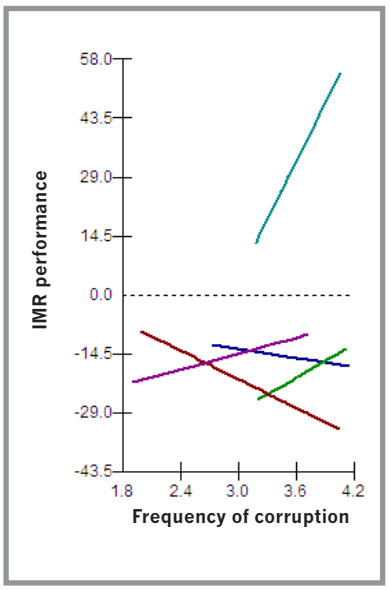

IMR performance
80
60
40
20
0
-20
-40
1
3
5
7
9
Corruption Bertelsmann Transformation Index

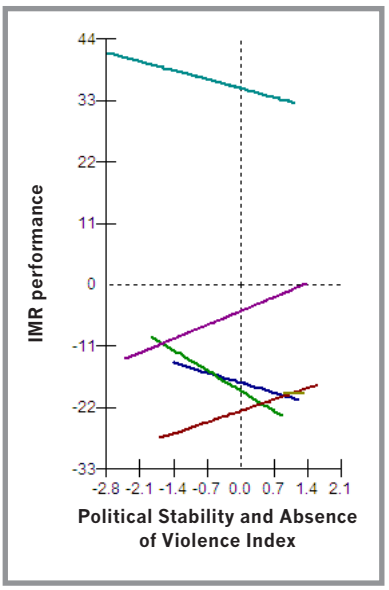

IMR performance
58.0
43.5
29.0
14.5
0.0
-14.5
-29.0
-43.5
0
3
6
9
12
Corruption Perception Index

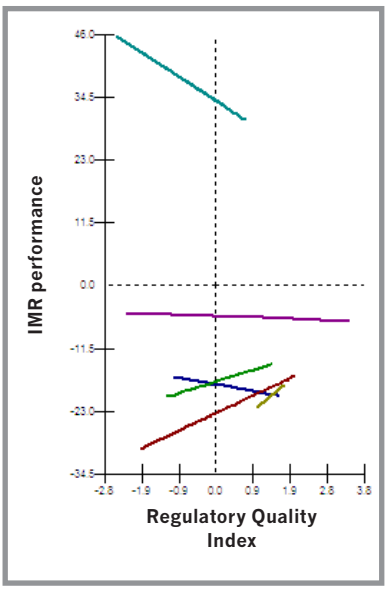

N. America
S. America
Africa
Europe
Asia

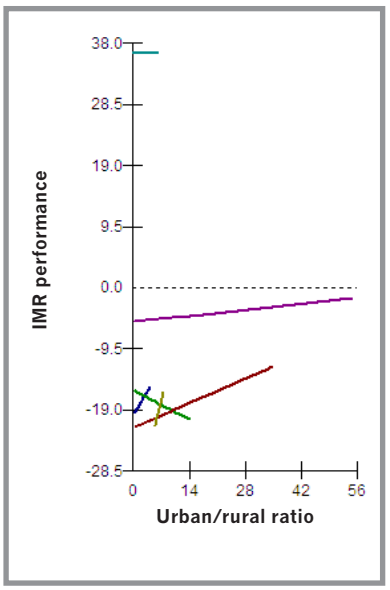

IMR performance
43.0
32.3
21.5
10.8
0.0
-10.8
-21.5
-32.3
-3.0
-2.3
-1.5
-0.8
0.0
0.8
1.5
2.3
3.0
Control of Corruption Index

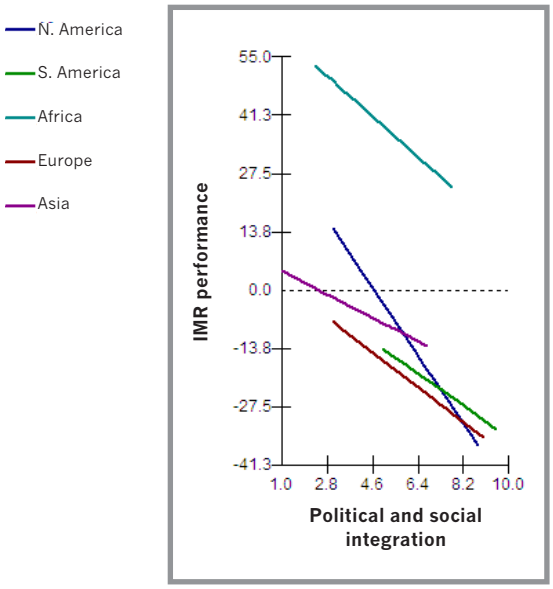

IMR performance
45.0
33.8
22.5
11.3
0.0
-11.3
-22.5
-33.8
0
70
140
210
280
Government Effectiveness Index


IMR performance
58.0
43.5
29.0
14.5
0.0
-14.5
-29.0
-43.5
1.8
2.4
3.0
3.6
4.2
Frequency of corruption


IMR performance
44
33
22
11
0
-11
-22
-33
-2.8
-2.1
-1.4
-0.7
0.0
0.7
1.4
2.1
Political Stability and Absence of Violence Index


IMR performance
46.0
34.5
23.0
11.5
0.0
-11.5
-23.0
-34.5
-2.8
-1.9
-0.9
0.0
0.9
1.9
2.8
3.8
Regulatory Quality Index


IMR performance
38.0
28.5
19.0
9.5
0.0
-9.5
-19.0
-28.5
0
14
28
42
56
Urban/rural ratio


N. America
S. America
Africa
Europe
Asia
55.0
41.3
27.5
13.8
0.0
-13.8
-27.5
-41.3
IMR performance
1.0
2.8
4.6
6.4
8.2
10.0
Political and social integration

RR/121/001

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